Vol. 50 No. 3 January 1957

Quarterly

of the

National Fire Protection Association

INTERNATIONAL

Promoting the Science and Improving the Methods of Fire Prevention and Protection Since 1896

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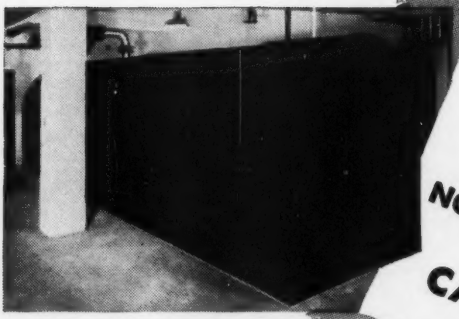

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Vol. 50 No. 3 January 1957

Quarterly

The Standard Technical Journal of Fire Protection for More Than Forty Years

The NFPA is a non-profit technical and educational organization devoted to the reduction of loss of life and property by fire with a total membership of nearly 17,000. The *Quarterly* is one of the publications regularly provided to members. Other membership publications include *Fire News*, *Advance Reports* to the Annual Meeting, a *Year Book*, and many leaflets, pamphlets and posters issued throughout the year on fire prevention and control. Six volumes of the National Fire Codes are available on an annual subscription basis, one volume free and others at reduced membership rates. For full details on available material ask for the free "List of NFPA Publications."

NFPA annual dues are $12.50 for Associate Membership of which $5.00 is for subscription to this Journal. National and regional societies or associations may apply for an organization membership for which annual dues are $100; such a membership entitles four individuals to receive the periodical membership publications.

Technical committees of the Association develop means to safeguard life and property through the publication of standards covering all phases of fire prevention and protection. Your membership in the Association affords an opportunity to keep abreast of these developments and, by being a member, you help support this humanitarian activity. Popular educational literature on fire safety is constantly being produced by the NFPA for distribution through its members to the general public.

National Fire Protection Association

International

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Quarterly

of the

NATIONAL FIRE PROTECTION ASSOCIATION

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Articles and accounts of fires appearing in the Quarterly are based on material forwarded to the Association. The Association, as a body, does not assume responsibility for the accuracy of the material printed herein.

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ROUTE OF
THE Hiawatha

Editorials

Reason to be Proud

FOR more than thirty years our Association has made an annual appeal to the presidents of large industrial concerns throughout the United States for financial support. This appeal has been sponsored each year by a committee of industrial leaders who have been willing to lend their names in support of our cause. Currently several hundred industries are making contributions to NFPA as a result of this solicitation and over the years the general field service activity of our Association has been wholly financed by these contributions.

The chairman of the original Sponsors Committee was the late Lammot du Pont, for many years President of the great du Pont organization. Mr. du Pont held the chairmanship of our committee for ten years and has been followed by Newcomb Carlton, Chairman of the Board of Western Union Telegraph Company, Henry D. Sharpe, President of Brown & Sharpe, Thomas J. Hargrave, Chairman of the Board of the Eastman Kodak Company, General Lucius D. Clay, Chairman of the Board of the Continental Can Co., and Colby Chester, Honorary Chairman of the Board of the General Foods Corporation. To all of these distinguished men our Association owes lasting gratitude.

We are very happy to announce that this year's Chairman is Mr. A. R. Fisher, President of Johns-Manville Corporation. The personnel of the Sponsors Committee under Mr. Fisher is as follows:

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The need for close adherence to NFPA Standards on the prevention of dust explosions is exemplified by this grain dust explosion and fire and many other similar cases cited in the dust explosion fire record beginning on page 216 of this issue of the *Quarterly*.

The fire shown at the left was at Amarillo, Texas and followed a grain dust explosion in the head house of the 150 ft. elevator at 6:30 P.M. on November 20, 1956. Two of the nine employees working in the area at the time were seriously burned. Within 30 minutes after the outbreak of fire the top 60 ft. of the elevator collapsed. At 7:45 P.M. fire broke out through all sides of the elevator and had involved the attached warehouse section. Five fire companies battled the blaze for over two hours.

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All of us have reason to be proud that such an important group of outstanding American businessmen are willing to sponsor the work of the National Fire Protection Association.

Why no Corporate Memberships

A SPECIAL form of "corporation membership" is sometimes proposed as a device by which NFPA might increase its income without a proportionate increase in expense. It is suggested that many companies would be prepared to pay higher dues for no greater benefits than associate members now receive, provided a special class of membership was established. Some associations provide a variety of membership classes designed to fit every purse. But, would this really serve the objectives of the NFPA?

The Board of Directors and the NFPA staff agree that the Association will achieve the greatest good by reaching the greatest number of people with its message. We believe that this can best be done by multiple associate memberships, maintaining the lowest dues level commensurate with the cost of the service rendered, rather than a single "corporate" membership with higher dues.

Many large corporations arrange for multiple memberships for key personnel, such as the plant safety director and plant fire chief, at their several plants. This plan not only gives essential support to the NFPA but assures the maximum benefits which NFPA can bring to the company and to its employees. This is more than technical information, more than fire safety propaganda.

The personal recognition implicit in any company management's decision to provide NFPA membership for an employee is a reward, an incentive, and a morale booster of value far beyond the nominal cost of the membership. The glow that comes from the knowledge that one's efforts are appreciated by management spurs many a man to greater loyalty, greater efforts and greater achievements. When these efforts and achievements are in the reduction of fire waste, the NFPA is eager to encourage them. How better can we do so than by making it as easy and as inexpensive as possible for such members to be enrolled?

More and more companies are coming to appreciate the peculiar advantages of multiple associate memberships for key fire safety personnel. Municipal fire departments, too, are finding that it pays off. We hope the trend will continue to grow.

Plan Now for Explosives Loading Facilities

REAR ADMIRAL F. D. Higbee, USCG (retired), Port Warden of the City of Los Angeles and chairman of the NFPA Committee on Harbor Emergency Organization, speaking before the Fall Conference of the NFPA at St. Louis, Mo., on November 27, 1956, emphasized a problem which will soon become critical, if not insoluble, if not met now.

During international emergencies there has always been the impelling necessity to expedite movements of entire shiploads of explosives from the major shipping ports. This has been because proper provisions have not been made during peacetime to provide proper explosives loading facilities reasonably close yet segregated from the chief regional ports. Today's picture is further complicated by the prospect of the need to fuel and defuel nuclear powered vessels. What are the hazards of this latter operation?

This problem has been further highlighted by the New York pier fire and explosion on December 3, which illustrates the hazard of the handling of explosives along with other cargo in a congested port.

A resolution adopted by the Pacific Coast Association of Port Authorities (U. S. A.) requested the U. S. Secretary of Defense, the Maritime Administration and the Atomic Energy Commission to immediately conduct such study and research as is required for the prudent location of suitable sites for the loading of explosives and to develop such sites in the interest of the public safety and welfare.

Rear Admiral F. D. Higbee, has spearheaded this movement of sensible preplanning. He points out that the U. S. Department of Defense has secured great tracts of isolated lands remotely situated for use as proving grounds for the lethal weapons essential to the national defense. No equivalent effort, however, has been exerted to set up sites near regional shipping centers at which explosives and nuclear weapons can prudently be assembled and handled. Unfortunately, few sites are left that could be reserved and made adaptable for such purposes. Urgent and immediate action is therefore indicated.

The handling of explosives is a lure to malicious mischief and sabotage. The most cunning efforts are contrived to make accidents appear as mishaps. Explosives loading areas, furthermore, lure the most determined and audacious enemy air attacks. Construction of special ports for this service would decrease, at least, the attractiveness of our principal ports as targets for subversive attacks and enemy bombings and such special ports could be constructed to reduce their vulnerability and be protected more efficiently and adequately against destruction by unfriendly acts.

This type of preplanning makes a good deal of sense.

Fire Protection Developments in 1956

By Percy Bugbee, General Manager
National Fire Protection Association

The past year has been one of many developments of substantial interest to all persons concerned with any phase of fire protection and fire prevention activity.

An important trend has been the continued dispersion of industry and also of mercantile areas away from the congested centers of cities to suburban and rural areas. From the fire protection standpoint, this trend has both good features and bad. It is certainly desirable to spread out when the possibility of atomic attack is considered and the equally important possibility of disastrous fires and conflagrations. On the other hand, there have been many instances where these important new buildings have been erected in areas where the water supply and fire protection are not sufficient to cope with the fire situation that could well develop. The annual studies that we publish of the large loss fires of the year show quite clearly the adverse effect of this trend in the increasing number of large losses that occur outside of dependable fire protection.

More FD Fire Prevention Activity

A trend that is all to the good is the strong trend, particularly during the past year, towards the acceptance by many fire departments, large and small, of their responsibility as a fire prevention agency as well as a fire extinguishing agency. In nearly all of our larger cities today, the fire prevention responsibilities and functions of the municipal fire department are fully accepted and are in most cases being carried out quite adequately. Many of the smaller communities as well, including many of the strictly volunteer fire departments, have come to recognize that efforts expended in fire prevention activity pay off in substantial reduction of fire losses as well as increased public acceptance of and support of the fire department.

Governors' Conferences

In the fire department field a major development has been the notable campaign undertaken by the International Association of Fire Chiefs, through its Fire Prevention Committee headed by Jay W. Stevens, to bring about a major reduction in loss of life in fires suffered by small children through regular inspections of all dwellings by the fire departments. More and more fire departments throughout the United States and Canada are undertaking home inspections and are finding out the value of this activity. This campaign was greatly stimulated during 1956 through a plan developed by Mr. Stevens for bringing the support of the governors of the respective states to this program. Already 20 states have held governors' conferences at which the governors have appeared in support of the home inspection program. Without doubt during the coming year similar governors' conferences will be held in the other states.

Other Fire Department Problems

Fire departments have been concerned during the past year with two other matters about which there has been much discussion. In many of our paid fire departments the firemen have been permitted to take other full-time jobs.

I would hazard the opinion that the majority of fire chiefs see the danger in this practice and recognize that its continuance will make it much more difficult to bring about appropriate wage and working conditions for the paid firemen. In a number of our large cities firemen have been prohibited from taking other jobs and these rules have been upheld in the courts in several instances.

The matter of integrating fire and police departments, particularly in small communities, has received far more attention than it deserves. Combining fire and police departments has been advocated by certain theorists in municipal government and has been tried in a handful of small communities over the years. We have no evidence which indicates that this will work to the advantage of the community or at any substantial reduction in expense to the taxpayers. We are convinced that integration of fire and police departments will provide neither competent police service nor competent fire service.

New Text on Fire Administration

An important addition to fire department literature made its appearance in 1956 in the new text on Fire Administration developed mainly by staff personnel of NFPA and published by the International City Managers Association. This is the standard text for municipal officials and fire chiefs on fire department administration and has had wide influence in this field.

County-Wide Survey

An interesting special survey was conducted by the Fire Services Department of NFPA during 1956. A study of all of the fire equipment in an entire county was undertaken and the information published in detail. The county selected was Plymouth County, Mass., which includes 29 separate fire departments with 66 fire stations housing 175 pieces of apparatus. This study has developed much interesting information of value to fire departments and manufacturers of fire equipment.

Children Unattended

The Fire Record Department of NFPA has noted an increase in fire tragedies involving small children. We believe this is due to the fact that more mothers are working under present-day conditions than ever before in history. This means that small children are often left alone or in charge of untrained persons. The Public Relations Department of NFPA is making strenuous efforts to focus attention on this problem and the need for doing something about it. Numerous fire departments have taken cognizance of this and are carrying on effective local campaigns to reduce these tragedies.

"Sparky" Gaining

It is pleasing to note that Sparky's Fire Department for children, organized in 1955, caught the imagination of many children in 1956 and thousands of children have enrolled and through this medium are learning the simple things that will save their lives in the event of fire. We have ample evidence that Sparky and the entire year-round Fire Prevention Campaign conducted under our sponsorship by the Advertising Council are constantly increasing the awareness of the general public to the need for fire safety.

New Edition of Fire Codes

Once again we issued the complete standards of the Association in six volumes of National Fire Codes, this year comprising a total of more than 4400 pages. The annual publication of all standards in this form has been recognized by a sufficient number of NFPA members and others as a service of practical value to the extent that we feel that we can issue these National Fire Codes annually. In no other way can those using fire standards be assured that they have on hand at all times the complete and up-to-date set.

There was much committee activity in the standard-making field during 1956 and a large volume of new mate-

rial was acted upon and adopted at the annual meeting of NFPA in Boston in June. New editions of such very widely used and important standards as the National Electrical Code, the Flammable Liquids Ordinance, the Building Exits Code, and the Standards on Liquefied Petroleum Gas, were adopted and are receiving widespread distribution.

Civil Defense

While there continues to be general public apathy and little interest on the part of fire protection people in matters of civil defense, there were two developments during 1956 in this field that hold special interest. The first was the appearance early in the year of the report of a special review committee to bring up to date the report of Project East River which was made in 1952. The review committee was made up of 14 of the original 75 members of Project East River, including two staff members of NFPA. This report proposed the setting up of metropolitan target zone areas and plans for defense of these areas based on the physical conditions, populations, and characteristics of each individual area. The committee again pointed out that the success of local civil defense activity depended upon existing municipal disaster services such as municipal fire departments. The committee urged a strong federal program to reduce the vulnerability of metropolitan target zone areas by improved plans for spacing and dispersing and by improved programs for construction and protection of buildings and elimination of fire hazards in the areas. This report has had the serious attention of the Department of Defense, the Office of Defense Mobilization, and the Federal Civil Defense Administration, as well as a committee of Congress.

The other development of special interest in this field has been the appointment of a special committee on Fire Research by the National Academy of Sciences-National Research Council. This work is sponsored by the Federal Civil Defense Administration and it is hoped that some of the leading scientists in the field of combustion will undertake research programs on mass fires and how they may be controlled.

Wood Shingle Roofs Again

We regret to report that during the past year the evidence indicates that there has been a recurrence of the potential conflagration hazard of the wooden shingle roof in certain areas on the West Coast and in the Southwest. When we recall the disastrous shingle roof conflagrations that occurred throughout the country in the early part of the century, it certainly seems unwise to recreate a conflagration hazard of this character.

NFPA Gaining Strength

The past year has been one of exceptional activity and expansion of all of the activities of our Association. The membership of the Association is at an all-time high and is almost 17,000. The demand for NFPA literature is at a constantly increasing rate and we estimate that well over ten million pieces of literature were distributed during the year — again an all-time high.

Employee Education Essential

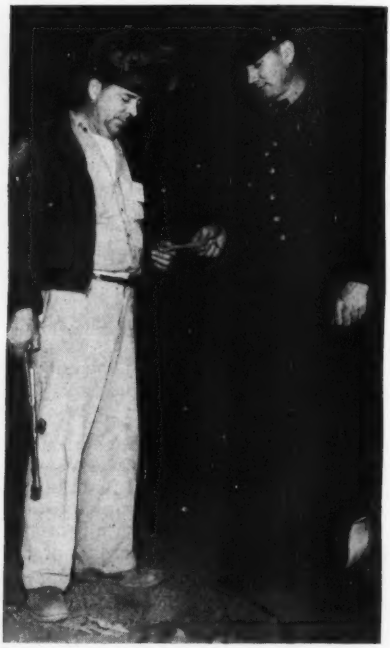
In 1955, 102 entries were received from industrial plants in the famed NFPA sponsored Fire Prevention Contest. In the previous year, only 84 plants entered. This evidence of increased industry interest in fire safety is also happily reflected in the fire record. The 1955 "large loss"* industrial fire experience showed a decrease of eleven fires over the average number experienced during the past five years. The records of manufacturing plant fire frequency in the U.S.A. also showed a drop from 38,200 incidents estimated in 1954 to 37,600 in 1955.

Chance Vought Aircraft at Dallas ranked top among the competing industries in 1955. Ford's Aircraft Engine Division in Chicago was second, Procter & Gamble's Milan Arsenal third. The roster of the first twenty winners includes other famous names in North America's industrial picture — Westinghouse Electric, United States Rubber, Canadian Pacific Railway, American Cyanamid (two plants), General Electric, General Motors, Sandia Corporation (two plants), North American Cyanamid Limited, Charles Pfizer and Company, International Harvester, Rheem Manufacturing Company, and the Aluminum Company of Canada. The Argonne National Laboratory and the U. S. Atomic Energy Commission Testing Station at Idaho Falls complete the list along with five other plants operated by Ford. Companies like these do not embark on fire prevention programs unless it has been proven to them that it pays. What is more important, positive results are not achieved unless the employee interest is aroused to the point where they realize that fire prevention also pays them in terms of job security.

Chief Claude L. McGlamery of Chance Vought discussed this approach to industrial fire prevention in a paper prepared for delivery at the last NFPA Annual Meeting when he was asked to accept the Grand Award plaque for 1955 on behalf of his company. He noted that education is the key and that the daily battle is to develop fire awareness among the employees. He pointed out that industrial plant operations are increasing in complexity and hazards. This makes it vitally necessary to keep employees abreast of the hazards introduced, to train them in recognizing hazardous conditions and to provide them with the tools and knowledge of fire control. He was convinced that people can be made to be careful, especially if they realize that being careless will cost them money. His job and the jobs of all the other employees at Chance Vought depend on the company being able to show a yearly profit. The company does not believe in "Production at any Cost" but rather in "Production with Protection."

Chief McGlamery illustrated his viewpoint by a true story which illustrated how the "human element" in fire safety can be disciplined. He reported that in a certain foreign city, a large area is occupied by tiny, ramshackle wooden shops. These little shops, built in rows, one after the other, make up a huge market place stretching over many blocks. They are owned individually, and when you look at them you realize that one small fire, out of control would, without a doubt, destroy the entire lot. You know, too, that such a conflagration could spread

*Fires each involving losses of $250,000 or over.



The fact that 5,287 permits were issued during 1955 has done much to make Chance Vought employees supremely conscious of fire safety.

throughout the teeming metropolis of well over a million people. Everything about the place seems to invite disaster: combustible materials, crowds of people, open fires for heating and cooking. You are astounded when you hear that there has not been a single incidence of fire in more than 20 years. A visitor not long ago asked a knowing native how on earth shop owners had managed such a record. It just didn't make sense. How? "That is simple," answered the native, "You see, it is against the law for any of them to have fire insurance."

The Chance Vought's educational program in fire prevention is illustrated in the accompanying photographs.

The photographs show only some phases of the year-round program in effect at this industrial plant which employs 13,000 men and women. Chance Vought produces the F8U Crusader, capable of speed beyond 1,000 miles per hour and the "Regulus I", a guided missile now operational from U. S. submarines, aircraft carriers, cruisers and shore bases. It moved to Texas from Connecticut "lock, stock and barrel" in 1948.

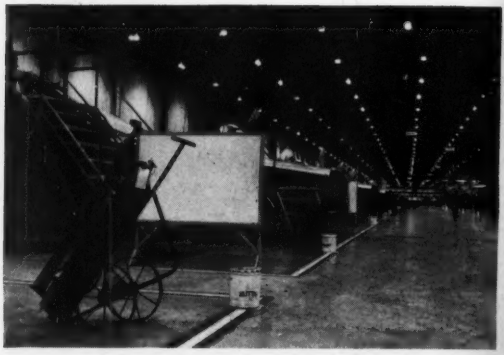
This equipment is available to back up the fire prevention program at Chance Vought and is manned by a 24-hour crew of 73 fire fighters under the inspiring leadership of Chief C. L. McGlamery.

Employee fire brigade training is an important ingredient in establishing and maintaining employee interest.

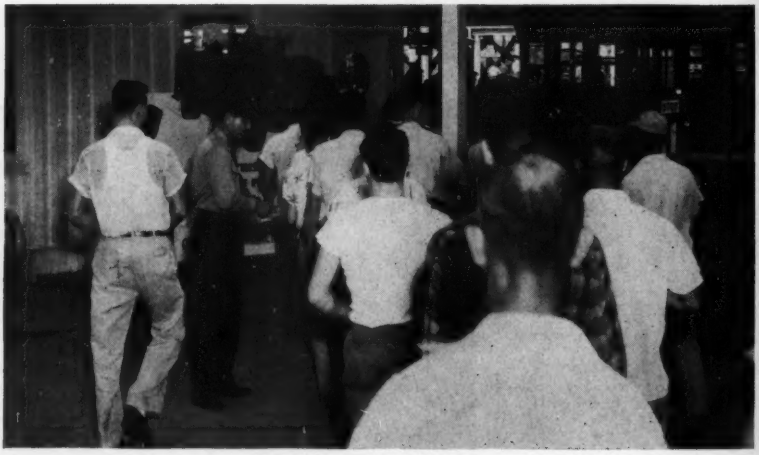
At the Main Gate, home-made display boards attract attention. Note casters which permit the shifting of displays around to different plant locations.

Plant-wide poster contests are another educational tool that Chance Vought uses to relate the problem to the individual.

Demonstrations of the usual type to illustrate particular hazards cannot be repeated too frequently to the ever-changing plant population.



A place to smoke is as important as a place not to smoke. The painted lines on the floor of this final assembly building at Chance Vought indicate permissible and prohibited areas.



Carrying a fire safety message home might just be the reason why one of these employees returned to work the next day.

HAZARDOUS AREA
NO SMOKING WITHIN RED AND WHITE LINES
SPARK PRODUCING EQUIPMENT NOT ALLOWED
By Order of the FIRE DEPARTMENT

Special signs for each special hazard area help to make the message valid and thus they attract the attention they deserve from employees.

Sparky Joins the Cumberland Valley Firemen

Item which can be found in the Keyser (West Virginia) *News-Tribune* at least once every week:

"Sparky Fire Company will meet tonight at 7:00 at the Fire Hall. Important business."

The "important business" can mean many things to the more than fifty youngsters who meet on the evening designated. Keyser Sparkies, as they are known, are a very original and active group and their deliberations are apt to range from plans to conduct a special fire safety program in town to a review of what each member's current contribution to the community's well-being has been.

Here, for example, is an extract from one meeting's minutes:

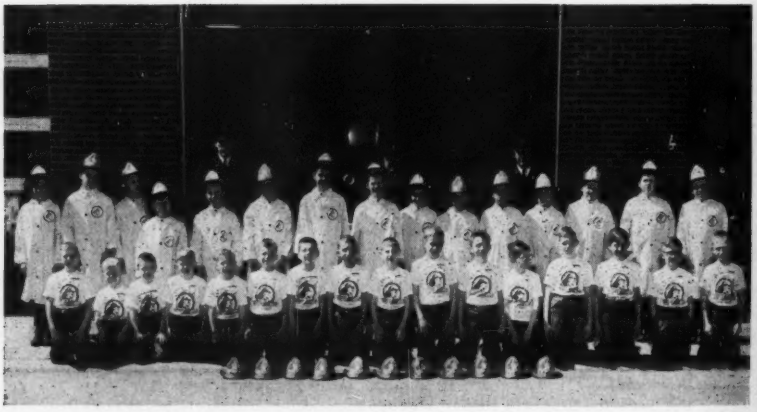
"The following officers of Company assisted Mr. William Carpenter in rescuing a cat perched in top of tree on Davis Street, Capt. James Briley, Chief Charles Briley, and Secretary Dennis Carpenter. Mrs. Bob Rice, owner of the cat, gave profuse thanks to members for rescue work. James Briley played big part in rescue by climbing beyond point reached by Mr. Carpenter."

And the members from time to time, again according to the secretary's minutes hear such reports as these:

"Olan Faulk reported that he took matches from a boy and gave them to his mother. The boy was striking matches on their garage."

On another evening:

"John McIlwee reported that someone had cast a cigarette away and it had started a fire which he put out. Tommy Miner reported that a neighbor had a habit of throwing matches and cigarettes in yard. On observing this he obtained an ash tray and presented same to her."



Wenner Studio, Keyser, W. Va.

Men of Sparky's Fire Department in Keyser (West Virginia) line up for a group photograph in full uniform. In the background are the advisors from the Keyser Fire Department which sponsors the Sparky unit. All the "uniforms" worn by the Sparkies have been purchased with funds from the group's own treasury which the youngsters administer themselves.

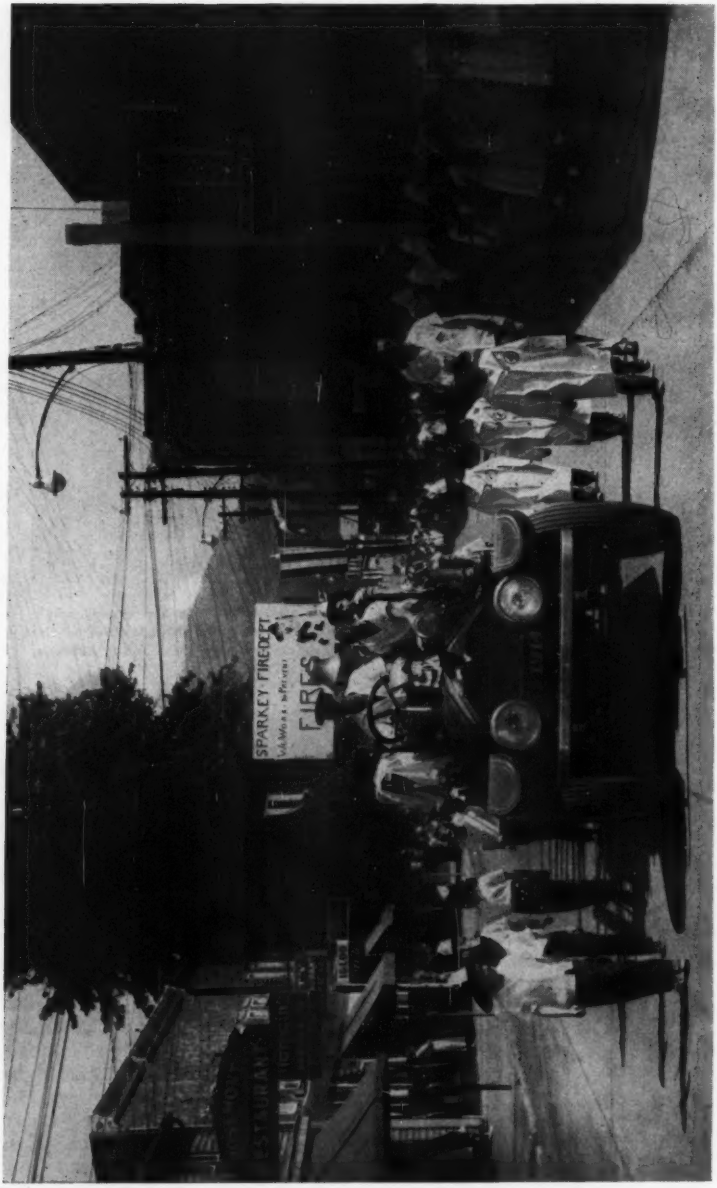
Keyser Sparkies last Christmas passed out free fire safety tags to the community's Christmas tree dealers. Left to right: W. J. Cross, Sparky Advisor and former chief of the Keyser Fire Department; Charles Briley, Captain of the Keyser Sparkies; Vernon Leatherman, local Christmas tree dealer; and Billy Chidester, Sparky president.

In action at such meetings and on many another occasion these days is the pilot model of a child fire safety project conceived early in 1955 by one of the country's older regional fire groups, the Cumberland Valley Volunteer Firemen's Association. Members of the Keyser Volunteer Fire Department had indicated a willingness to be the first to try out such an idea. And the Association, according to C. L. Jacobs, a director and until recently secretary of the Cumberland group, had high hopes that Keyser's example might encourage the formation of many more similar children's programs by Association members.

Now — over a year and a half later — there is every indication that the Keyser Sparkies have done their job well. The Cumberland Valley Volunteer Firemen's Association reports that a number of other Sparky units have already been formed or are planned throughout the four-state area — Pennsylvania, Maryland, West Virginia, and Virginia — in which the Association's membership and activities are centered.

One thing is certain, in fact it became almost immediately apparent soon after the first Sparky group started in Keyser: differences in local conditions make it impossible to follow the Keyser example to the letter in other communities. Limestone, West Virginia, right next door, started a Sparky Fire Department soon after Keyser and today they differ in several of their activities.

Cumberland Valley Association executives who have been pushing the



Proud Keyser Sparkies parade in a neighboring community with their own engine. The 1914 pumper was purchased and is maintained by the youngsters with funds they raised themselves through various community endeavors. Certain to be the hit of the many parades in which they participate, the Keyser Sparkies pay their own way to and from such affairs.

idea — men like Mr. Jacobs, also Mr. Roy R. Allsopp, a mutual insurance agent of Waynesboro, Pa., and E. Wade Thomas, recent past president — now realize that there is no set pattern to Sparky groups in different localities beyond the common objective of creating a more positive attitude about personal fire safety as well as a constructive understanding of the fire department's mission. Of course, there are other common characteristics which, they claim, will denote a successful Sparky undertaking in any community; these include general financial support by the industry and merchants, understanding cooperation and support by the civic and social groups as well as the service and veterans' organizations. Important, too, in every case is the local school system's acceptance and cooperation.

Here's a closer look at Keyser's example . . . from the time it started through some typical activities to the present:

On a Saturday morning in July of 1955, twelve boys between eight and twelve years old were solemnly sworn in as charter members of the Keyser, West Virginia, Sparky's Fire Department. The youngsters were sons or friends of active members of the Keyser Volunteer Fire Department. However, membership doubled almost immediately upon the announcement in the local paper that a Sparky's Fire Department had been formed.

From the first, the Sparky unit was organized along a pattern very similar to that of its parent organization, the Keyser Fire Department. Officers were elected; these included a president, vice president, a secretary, chief, a captain, and a treasurer. In a demonstration of the seriousness with which the municipal officials regarded the project, Keyser's Mayor, John Freeland, formally installed the officers upon their election.

Supervision and guidance at the beginning was furnished by W. J. Cross, former Chief of the Keyser Fire Department, along with Captain George W. Chidester and fireman Robert R. Diehl.

Naturally, finances were an important consideration right away. Sparky members paid a quarter upon joining and for this they received their Sparky Inspector's badge, I. D. card, and manual. After that, all other equipment and activities in which any member may participate usually are covered by the Sparkies own Treasury. And in their year and a half of existence, the youngsters have maintained an extremely healthy bank account.

The Sparky treasury in Keyser receives funds from a number of sources. Most income to date has been obtained by the members through special events such as tag days on which Sparky members sold small paper squares to the general public and at the same time explained the organization's objectives. The first of these tag days, for example, resulted in a return of $123.00 — quite remarkable in a community with a total population of around 7,000 people. There have since been other tag days with similar amounts received.

Another important source of funds for the Sparkies has been prize money. Soon after the junior department was founded, it won a $10.00 prize for participating in a nearby community's firemen's parade. On other occasions the Sparky's have won as much as $50.00 in prize money; the $50.00 award resulted when the Sparkies first paraded with their own fire engine which they had previously purchased with their own funds. The Sparky engine, "Old Lil," is a 1914 pumper and quite often can be depended upon to win the prize as the oldest piece of motorized apparatus in any parade. The Sparkies have also received financial help in the form of donations from interested adult groups in Keyser; the youngsters have conducted at least one fund-raising food sale; and in the course of every meeting, the loose pennies in the members' pock-

ets usually find their way into the treasury.

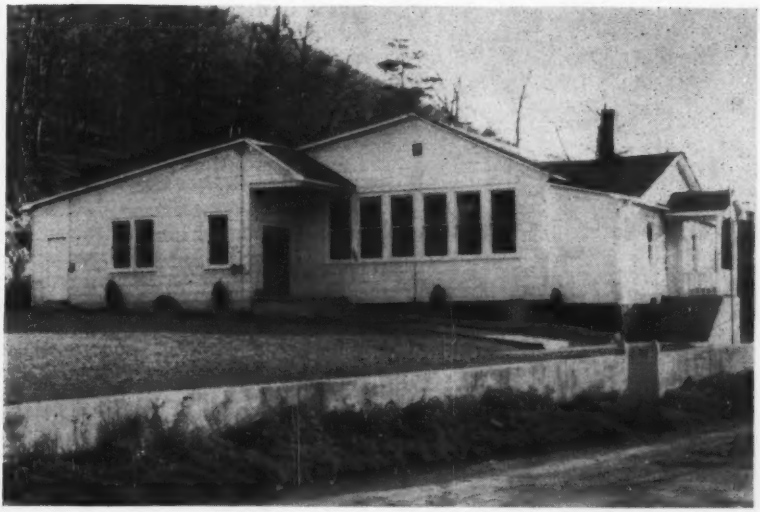
Another important form of support not as measurable as direct financial donations has been the fire prevention advertising which the merchants and other organizations in Keyser furnished upon request of the Sparkies. These advertisements appear in the Keyser paper during Fire Prevention Week and on other special dates.

On the other side of the ledger the Sparkies' expenses in addition to the purchase of the old fire engine have included "uniforms" for all members. Uniforms as such are Sparky raincoats, the straw Sparky fire hats, and Sparky T-shirts. Such uniforms remain the property of the organization and when a Sparky becomes over age (13 years) and must resign, he turns in his uniform. Other expenditures have included the cost of printing up the tags mentioned above as well as special fire safety tags for Christmas trees during the holidays.

As the Keyser Sparkies have become better established, their fire safety promotional efforts have become increasingly ambitious. On top of tagging Christmas trees, the Sparkies have issued special warnings through the newspaper on the various holiday hazards around Hallowe'en and Christmas. Also, it was the Sparkies who requested and ultimately sponsored Keyser's first formal Spring Clean-Up Week this year. Latest project was a "Sparky Queen" contest which was climaxed by a Hallowe'en party jointly sponsored by the Keyser Volunteer Fire Department and the Sparkies. Over 700 youngsters attended the party and participated in the contest with one young lady being named "Miss Sparky of 1956." The event was so successful both as a party and as a selling medium for Hallowe'en fire safety that the Sparkies are planning to repeat it annually from now on.

Keyser Sparkies are extremely popular with the sponsors of all types of parades throughout the entire area. They receive frequent invitations to participate in these functions and make a big hit whenever they do. Still another noteworthy activity of the

Members of the Limestone Sparky's Fire Department not only hold their meetings in the community school, but their principal and teacher, Miss Madalyn Bazzle, has helped them relate the significance of fire safety to all their classroom subjects. These ambitious youngsters are currently occupied in drawing up a fire survey map for their rural community showing the location of all structures, roads, bridges and water supplies — at the same time they're making up fire department route cards for all dwellings.



It takes the hundred pupils who attend the Limestone school above only 19 seconds to evacuate all classrooms. They conduct frequent drills not only in school but in their homes as well. The school is also the official clubhouse for the Limestone Sparky's Fire Department.

Sparkies is that of visiting local industrial plants and observing manufacturing operations and the fire protection equipment and safeguards.

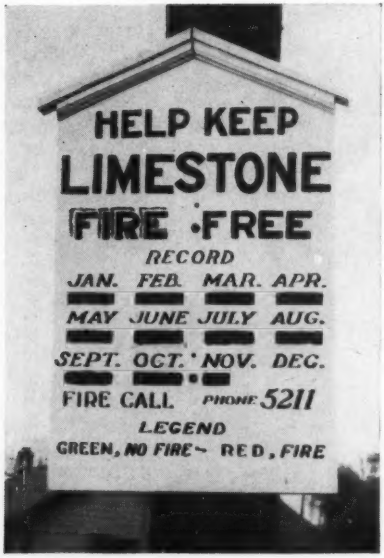
Just across New Creek from Keyser is Limestone. Also in West Virginia, Limestone on the other hand, is much more spread out, less urban than Keyser. On top of the geographical differences there's a very great distinction, too, between the Sparky unit which was founded in Limestone in January, 1956, and the older Sparky group of Keyser.

Perhaps the most striking characteristic about the Limestone Sparkies is that it is wholly incorporated within the school. As a matter of fact, its chief sponsor and guiding spirit is Miss Madalyn Bazzle, Principal and teacher of the Limestone school. Working with her to help her get and keep things going have been Captain Chidester and Fireman Diehl of Keyser. Virtually all Sparky activities either stem from or are incorporated into some aspect of the curriculum in all grades. Currently there are 100 pupils in the Limestone school.

The youngsters in Limestone have equaled their counterparts in Keyser when it comes to ambitious projects. Their largest project — one designed to require an entire year's effort — is a rural fire survey of the entire Limestone area. They are preparing a map showing the location of all residences, outbuildings, barns, ponds, bridges, roads, and sources of water supply.

In conjunction with the survey, Limestone Sparkies are making up route cards for every dwelling and these cards contain the name of each family, number of persons in the dwelling, type of structure, heating equipment, again the nearest source of water and other pertinent fire protection information. As each house is numbered on the route card, a corresponding number will be put on the map at the exact location of the dwelling.

When this project is completed the map and route card index will be



This sign greets all motorists entering Limestone. At the time the picture was taken, all the bars under the months were green indicating that fire so far has been kept out of Limestone. And most folks have given a large amount of credit to the town's Sparkies for this commendable record.

turned over to the Keyser Fire Department which serves the Limestone area. The Sparkies plan to retain a duplicate route card index.

At the same time as the Limestone group works on its major project, it has accomplished a number of other fire safety measures. Motorists, including the folks driving home from work each day, as they enter the Limestone area at the fork of the two roads coming into the community can't miss the large sign which the Limestone Sparkies have posted there. The sign carries the motto, "Keep Limestone Fire Free" and underneath is painted the name of each month of the year. An empty square beneath the name of the month is painted green if there have been no fires for that month and red if there has been an alarm. At latest report, every month to date has a large bright green bar on the Limestone sign. The sign, incidentally, carries the fire department phone number.

The Limestone Sparkies are the sponsors of the fire prevention and clean-up campaigns in their community. Cooperating with them particularly in the clean-up campaign is the Limestone Farm Women's Club which, it is reported, has been so inspired by the youngsters' enthusiasm that it now plans an all-out beautification project to include tree and shrub planting, general paint-up and improvement of the entire area.

Each Limestone Sparky has practiced giving a fire alarm from his home — including the transmission of the proper location and other necessary information which the Keyser volunteers require.

Each Sparky, too, has practiced home fire drills and has been instructed on

"Miss Sparky of 1956" in Keyser, West Virginia, is Clara Belle Reel (center). She was selected at the big Hallowe'en party for youngsters which was sponsored by the Keyser Sparky's Fire Department cooperating with the regular volunteer department. Runners-up were Karen Sue Woy (left) and Linda Lou Long (right). Miss Sparky received a gold fireman's helmet and a trophy and holds her title until next year's Hallowe'en party.

teaching the rest of his or her family how to be ready and exactly what to do in case of fire in the night. A part of their training also has been devoted to the rescue of aged persons or invalids.

Last Fire Prevention Week, the Limestone Sparkies as a part of their language course wrote radio scripts on fire safety. Among themselves, they selected the three they thought best and these were presented over the Keyser radio station, WKYR as a special feature of Fire Prevention Week.

Among their recent Hallowe'en fire safety activities was a special article which they prepared for the newspaper on how to prepare and use a flame retardent solution for Hallowe'en costumes.

The Limestone Sparkies do have a formal organization despite their nearly total identity with school. They meet weekly, keep minutes and elect officers just as does the Keyser group. While, however, they do not have the constant counsel of the fire department, they undoubtedly benefit equally from a trained teacher's interest and skill at relating their learning to the realities of life. These youngsters will remember all their lives the lessons they are learning now. And certainly fire is one of life's most significant lessons.

SPARKY PLEDGE

Youngsters joining both the Keyser and Limestone Sparky's Fire Departments take the following oath which was written by Roy R. Allsopp of Waynesboro, Pa. Mr. Allsopp is Chairman of the Public Relations Committee of the Cumberland Valley Volunteer Firemen's Association.

I _____ PROMISE TO ALWAYS DO MY BEST TO BE A GOOD MEMBER OF THE SPARKY FIRE DEPARTMENT. I SHALL AT ALL TIMES CONDUCT MYSELF IN A MANNER SO THAT ALL MEMBERS OF THE SPARKY FIRE DEPARTMENT, AND ALL FIREMEN IN GENERAL SHALL BE PROUD OF ME. I WILL AT ALL TIMES TAKE GOOD CARE OF MY EQUIPMENT AND SHALL ALWAYS KEEP IT CLEAN AND NEAT.

I WILL AT ALL TIMES FOLLOW THE INSTRUCTIONS GIVEN TO ME BY CHIEF _____ OR WHOEVER IS PLACED IN CHARGE OF THE SPARKY FIRE DEPARTMENT. I WILL ATTEND ALL MEETINGS AND STUDY ALL INSTRUCTIONS GIVEN TO ME.

I _____ PROMISE TO SINCERELY TRY TO KEEP ALL OF THE PROMISES IN MY OATH AS A GOOD MEMBER OF THE SPARKY FIRE DEPARTMENT SHOULD DO.

State Interests in Explosives Transportation

By Capt. Carroll E. Shaw

Connecticut State Police Department

Commanding Officer, State Fire Marshal's office

The subject of my talk today is State interests in the transportation of explosives and other dangerous articles. I am stating primarily the position of the police authority of the State of Connecticut, but it is a position in which, I am quite sure, there will be substantial concurrence in all 48 States. Our interest—and it is a very vital one indeed — concerns the protection of every man, woman and child against the hazards of explosives transportation, whether that transportation is in intrastate or interstate shipment.

We are really not too concerned over whether the Constitution in authorizing Congress to regulate "commerce-among the several States" meant the regulation of interstate commerce. If the accepted meaning as we know it today of "commerce — among the States" is too narrow, and if the term "commerce" includes all gainful activities within the State whether interstate or not, and use of the word "interstate" has distracted attention from the constitutional phrase "among the several States," we are again, from a police point of view, not particularly interested at this time except specifically where the transportation of explosives is concerned.

Under the provisions of Public Law 772, House Rule 3190, enacted by the Congress on June 25, 1948, the Interstate Commerce Commission was delegated the authority to regulate the transportation of explosives and combustibles. If, as has been held, the States are without authority to interfere in interstate commerce because Congress has legislated on the subject and has thus called into play its exclusive power to regulate all interstate commerce, then all States, in the interests of public safety, should work diligently for a re-examination of the whole question of transportation by motor carrier of explosives and other dangerous articles.

Exposing the public as it does to the danger of probable injury, the transportation of explosives is an intrinsically dangerous operation. One who engages in it acts at his own peril and most certainly is not entitled to the protection of any law or regulation that fails to provide on a State level full protection to all against the obvious hazards involved. It has been held that as Congress has legislated upon this subject of explosives transportation and manifested its intention to deal therewith in full, that the authority of local or State jurisdiction is necessarily excluded; that it is elementary that the right of a State to apply its police power for the purpose of regulating interstate commerce exists only from the silence of Congress on the subject and ceases when Congress acts and calls into play its exclusive power. I say that action to date on the matter fails to provide adequately for the public safety.

ICC Regulations

When Congress found the comprehensive regulations needed for explosives too intricate and detailed for its own processes, it delegated the task of framing regulations to the Interstate Commerce Commission, and made a knowing violation of them criminal. If — and I take the opposite view — some of these regulations in certain respects are other than loosely drawn, lacking in tightness, indefinite and

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This paper was presented at the Fall Conference of the National Fire Protection Association, Hotel Statler, St. Louis, Missouri, November 27, 1956.

inadequate to protect the public, a violation thereof conjectural, I still ask, what effective program of enforcement is being carried on at a Federal level to enforce these regulations and to provide that measure of safety to which they are entitled, to all people in the States through which explosive shipments are transported?

With no offense intended or implied as I have only the greatest respect for the agents of the I.C.C., I say that they have just not been provided with the tools necessary to do a thorough job. This weakness is brought into sharp focus by a comparison of their token force with the large, excellently trained and equipped law enforcement organizations of the States.

I ask, how effective can a program of enforcement be, when assigned to the individual States are only a handful of men whose all-out enforcement efforts are generally limited to two or three spot checks a year in conjunction with local police authority? It is utterly absurd to imagine that this effort, however sincere it may be, constitutes valid enforcement, and those who advocate the application of I.C.C. regulations to the exclusion of all else show a disregard for the rights and safety of others.

Responsibility

It is the duty and the responsibility of all those who are concerned with this problem, including the manufacturers of explosives and the various associations of motor carriers, to use their influence to provide the inspectors of the I.C.C. with the necessary money, manpower and equipment to do a complete job — or to advocate and actively support national legislation giving direct, unquestioned and legal authorization to the States.

In the 1949 Code of Federal Regulations, Sec. 190.30 provides that where specifically indicated the States are precluded from establishing or enforcing local laws relating to safety. The areas wherein it has been "specifically indicated" and covered in parts 190 to 197 of the Code include physical requirements of drivers, driver experience and skill, knowledge of regulations, age, knowledge of the English language, physical examination, driving while ill or fatigued, use of alcoholic beverages, schedules to conform with speed limits, use of equipment and driver inspection of brakes, steering mechanism, lighting devices and reflectors, tires, horn, windshield wipers, rear vision mirrors, coupling devices, fire extinguishers, spare fuses, tire chains, hand tools, warning devices, distribution and security of load, doors, tarpaulin, tail gates, interference with driver, stopping requirements at grade crossings, caution under hazardous conditions, unattended vehicles, stopped vehicles, disabled vehicles, emergency signals, protecting dangerous cargoes, accidents, transportation of unauthorized persons, driving by unauthorized person, transfer to sleeper berth, detection of carbon monoxide, flame-producing heaters, disengaging motor power, etc., etc.

Paper Rules

It is true that these are comprehensive and rigid regulations, but we move in apprehensive dread when we realize that they are purely and simply a set of "paper rules" which have the effect of lulling our people into a false sense of security.

To consider these regulations as self-enforcing is a procedure as defective as it is dangerous to the public welfare.

It is so ridiculous that it might be ludicrous except for the fact that the regulations remain to a large extent as an incoherent barrier against State enactment or enforcement of local regulations on the subject. What a boon to mankind in general, and to the police profession in particular, if all we had to do to prevent crime and provide safety on our highways was to pass laws and regulations, then all but eliminate any real enforcement program.

There are on file in the office of State Police Commissioner and State Fire Marshal John C. Kelly two resolutions adopted by fire service organizations in two different counties of Connecticut calling for the prohibition in certain areas of the State of all vehicles carrying explosives or other dangerous articles.

Three Fire Fighters Killed

The men of the fire service of Connecticut have good reason to view with alarm the unsupervised shipments of explosives and other dangerous articles over our highways. A vehicle engaged in the transportation of dangerous articles was involved in an accident in one of our small towns located on a heavily traveled highway. Striking a tree, the vehicle burst into flame and the fire department was called to the scene. Before the fire was brought under control, three fire fighters were killed and seven fire fighters and four pedestrians injured. I shall not attempt at this time to resolve the varying viewpoints of the persons involved as to whether there was proper placarding, but it should suffice to say that the records of the Port of New York Authority disclose violation after violation of the regulations regarding placarding, one result of which was the enactment by the legislatures of the States of New York and New Jersey of laws covering the subject.

On March 23, 1950 Mr. Billings Wilson, the Director of Operations of the Port of New York Authority, speaking in support of Assembly Bill No. 50 of the State of New Jersey at a legislative conference in Trenton, listed 18 separate and distinct violations over a short period of time of I.C.C. regulations observed by the Authority's own police officers.

I say further that requirements which fail to provide for the placarding of vehicles carrying dangerous articles *below* certain stipulated amounts is wrong. Even if true that generally speaking the degree of danger corresponds roughly with the quantity of material carried, it is a principle fully recognized by decisions of State and Federal courts that wherever there is any business, the carrying on of which presents any danger to life or property, it is not only within the power of the States but it is among their plain duties to make provisions for preserving the public safety, — and the matter will have to be clarified.

Fire fighters, police officers and other safety officials are entitled to know — and at once — whether the cargo of a truck involved in an accident is dangerous so that immediate steps can be taken to safeguard the lives of the firemen and police officers and the public — and to prevent general disaster to the surrounding neighborhood.

It is not feasible to draw a definite line between the commerce Congress may regulate and that which it may not, in a way that all requirements are clearly satisfied; and even if this were practical, no such hard and fast delineation should be attempted. Explosives are most certainly in a different category than washing powder, toothpaste, fruit, soup or soap, and the Supreme Court itself has considered this very question.

Speaking of the commerce power, the Court has said that whatever terminology is used, the criterion is necessarily one of degree, and must be so defined. This does not satisfy those who seek for mathematical or rigid formulas, but such formulas are not provided by the great concepts of the Constitution, such as "interstate commerce," "due process" "equal protection." In maintaining the balance of the Constitutional grants and limitations, it is inevitable that we should define their applications in the gradual process of inclusion and exclusion.

State Legislation

There is a difficulty, it is true, in all cases of this character in drawing the line

precisely where the power of Congress ends and the power of the State begins, but the line must be drawn between a State's right to protect its people by acceptable legislation and the extent to which that legislation burdens interstate commerce. The case of Hendricks vs. Maryland, 235 U.S. 610, 1915, was the first of many cases (and in view of the almost unbelievable increase in the volume of shipments of freight by motor carrier there will be many more) in which the State and Federal Governments clashed on control of highway traffic passing through the states. To provide by State legislation safety to all users of our highways and residents living adjacent thereto we maintain is not an unlawful burden on interstate commerce, and is a legitimate exercise of police powers.

In connection with the "original package" doctrine it has been held generally that goods imported into a State are in interstate shipment and above State regulations to control as long as they are in the original package in which they were placed by the shipper; that the status of "interstate" remains, even when the cargo is consigned to several consignees as long as the destination of these shipments was known at the place of origin. I ask then, what are the States to do about large cargoes of explosives that are transported by carrier to a magazine within a State from which point distribution of several individual shipments of such cargo is made to other parts of the State in smaller trucks?

Obviously, to consider these trucks to be operating in interstate shipment above and beyond the control of local authorities is extremely dangerous and not in the public interest, and it is time for adjustments and modification of all federal laws and regulations concerning the transportation of explosives.

Members of Congress, Judges, and even Justices of the Supreme Courts are people and subject to human frailties. They are neither infallible nor are they aided by an ability to look into the future. I ask, who could possibly, even a few years ago, foresee the tremendous advances that were to be made by the motor truck industry in America, or the enormous increase in the use of explosives?

All Must Work Together

At times the courts may recognize earlier concepts to be wrong or unsuited to new conditions, and the Commerce clause is no exception, but the Court has not hesitated to use the inherent power of all appellant tribunals expressly to overrule earlier decisions. There is no valid reason why all concerned with the problem of explosives transportation, working together, cannot provide for the safety of our citizens without placing any undue hardships on the industry as a whole.

I am firmly convinced that the interest of the manufacturers of explosives and the associations of motor carriers in our problem of safety is real and sincere. I do, however, object to the labeling of the efforts of public spirited citizens in the several states who are wrestling with the problem as "sponsored by the brotherhood of railroads," and all proposed legislation on the subject called "infamous."

As great as the legal responsibility of each State to provide for the health and safety of its people is the moral responsibility of all those in any way involved in the business of the transportation of explosives and other dangerous articles, to work for legislation which will remove all obstacles which presently prevent the States from providing fully for safety from the hazards of a business which is inherently dangerous. The transportation and explosives industries, for their own benefit, must meet the challenge of these changing times and lend their full support, cooperation and powerful influence to those outside those industries whose only consideration in asking for corrective action is the public welfare.

Flammable Liquids from Container to Process

By Stanley F. Spence

Director, Safety and Loss-Prevention, American Cyanamid Company

This presentation is a series of illustrations which starts with the tank car station, covers tank car unloading, follows the course of the flammable liquid to drums and smaller containers and finally treats the flammable liquid where it becomes part of a process in the plant. The illustrations are of installations, equipment and procedures of the American Cyanamid Company, to the men of which I must express appreciation for diligent application and follow-up of good loss prevention principles and for the considerable amount of work which was necessary to assemble these photographs and diagrams.

The photographs and drawings do not cover all of the situations involving fire problems where flammable liquids are involved, but an attempt has been made to treat procedures dealing with the most common and most important situations. Drums and containers for small amounts of flammable liquids are common to many plants; bulk tankage equipment depends on the total amount of any individual liquids handled. These storage facilities and process equipment would provide a great variety of examples. Enough cases have been included to stay within the time and space limitations of a single presentation, and they cover the subject comprehensively enough to indicate the sort of problems involved.

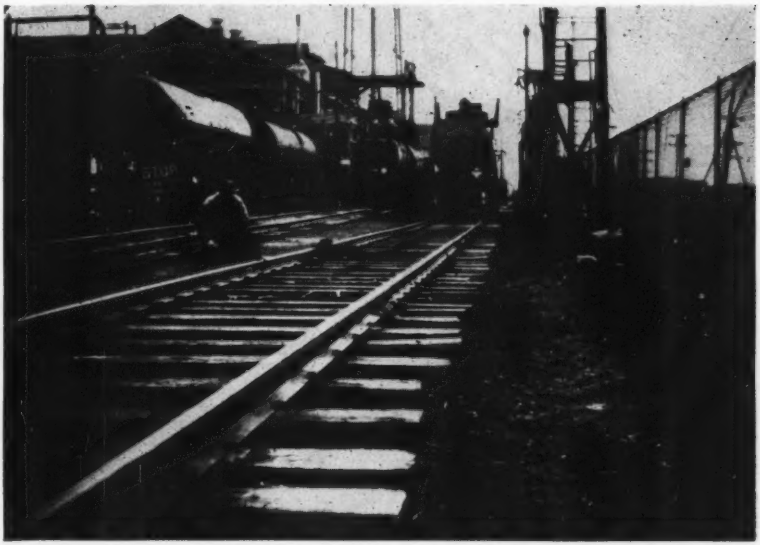
Two administrative procedures are worth mentioning which are used by our Company. One of these is to require a circumstantial report of each fire. We provide a Fire and Damage Report form which the operating superintendent signs and which is reviewed by appropriate company executives. This gives us the technical data on each case which is used to make improvements in equipment and procedures to avoid repetition of the trouble. This is an important part of a loss-prevention program. This is supplemented by a monthly summary of all of the fire and damage reports turned in from the various plants of the Company. This is circulated to general office management, division and plant managers, plant safety and loss-prevention supervisors.

I wish to emphasize that the old concept of a flammable liquid as defined only by flash point is insufficient for sound engineering design for loss prevention. In such design, additional characteristics of the flammable liquid are considered, among them (a) low boiling temperature combined with high vapor pressure, (b) unusual instability or chemical reactivity, (c) low ignition temperature, (d) extreme toxicity and (e) high and low conductivity. The latter characteristic is generally defined by the dielectric constant of the material.

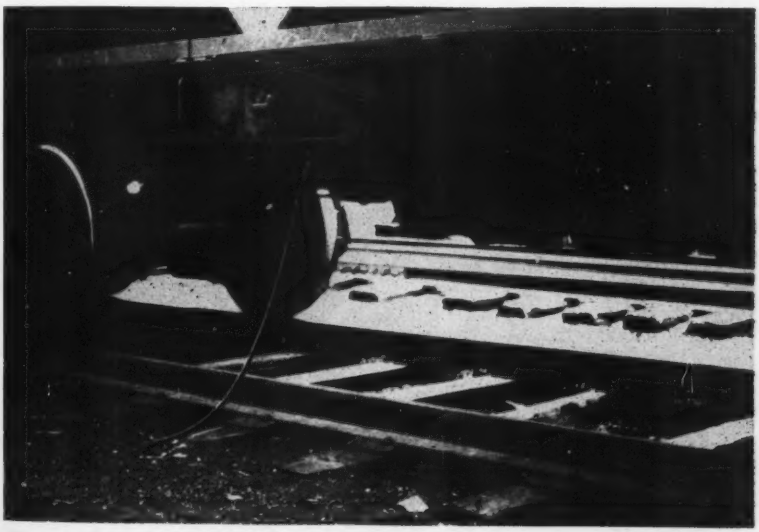
Examples of materials with high dielectric constants are methyl alcohol 33, HCN 95, acetaldehyde 22, acrylonitrile 38 (at 33.5 megacycles), acetonitrile 39 and acetone 21. Examples with low dielectric constants are carbon disulfide 2.6, ethyl ether 4.3, toluene 2.4, and amyl acetate 5.07.

This is not a formal technical paper covering a code of safe industrial practice in the handling of flammable liquids. It is simply a presentation of how principles of safety are applied in practice to the particular flammable liquids used in one company.

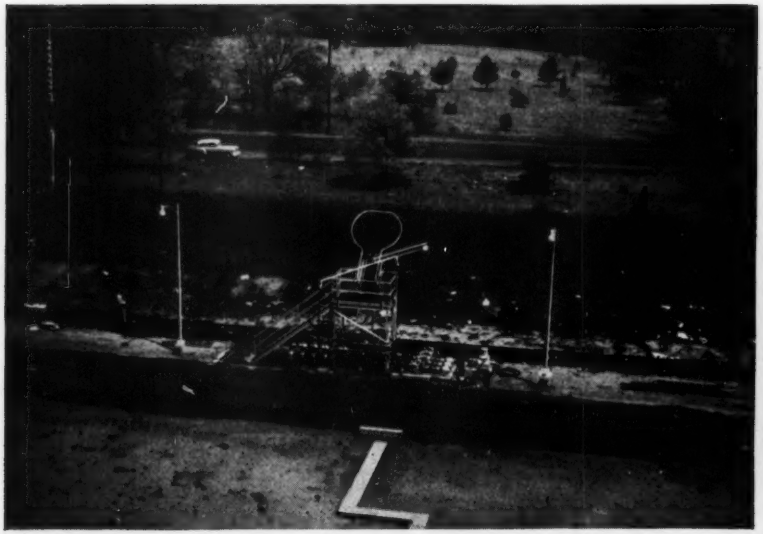
This article is based on a presentation by the author at the 60th Annual Meeting of the National Fire Protection Association, Boston, June 1956.



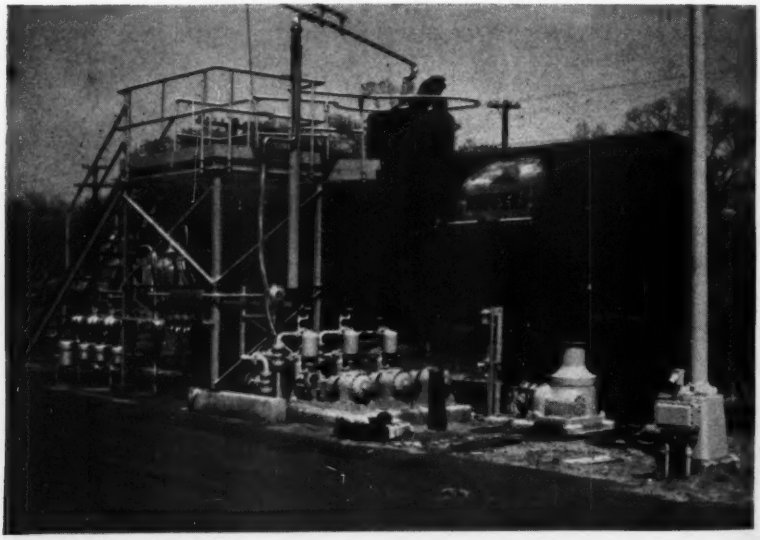
After a tank car is spotted, but before it is connected up, good practice requires that the derail and warning sign be set.



Grounding connection to chassis of tank car.

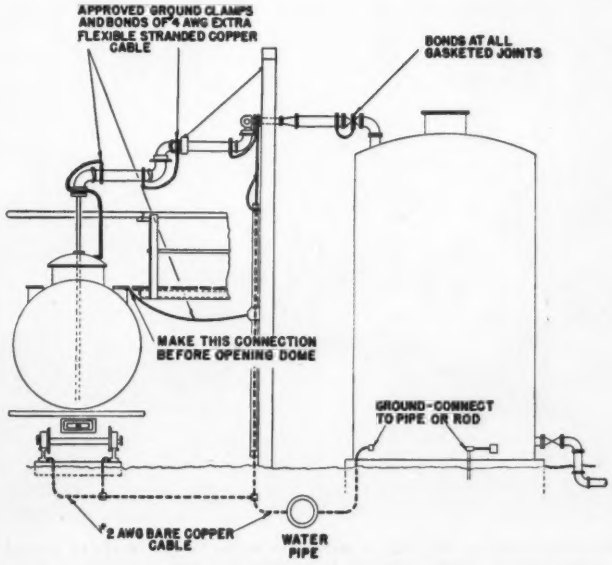


Tank car platform at Wallingford plant. The platform includes the piping and connections for taking styrene and other solvents from tank cars, unloading pumps and electrical drive equipment. The piping goes from the unloading platform to underground tanks through the concrete-protected pipe trench in the foreground.

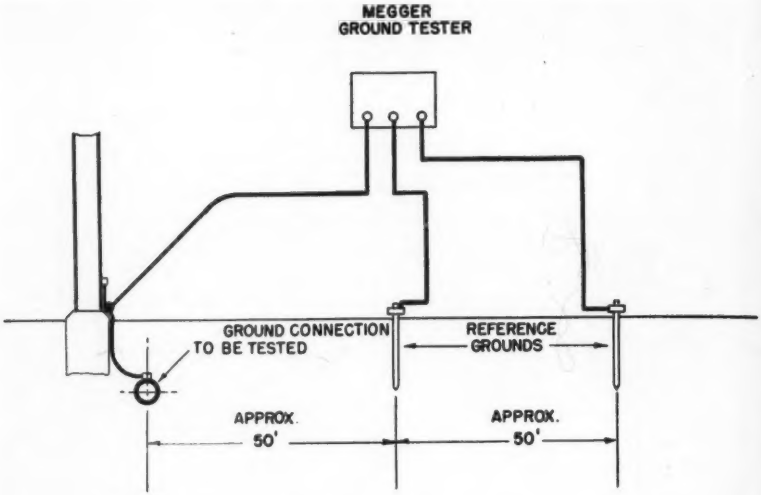


This is a general view of the tank car unloading site with everything set up for safe and effective unloading.

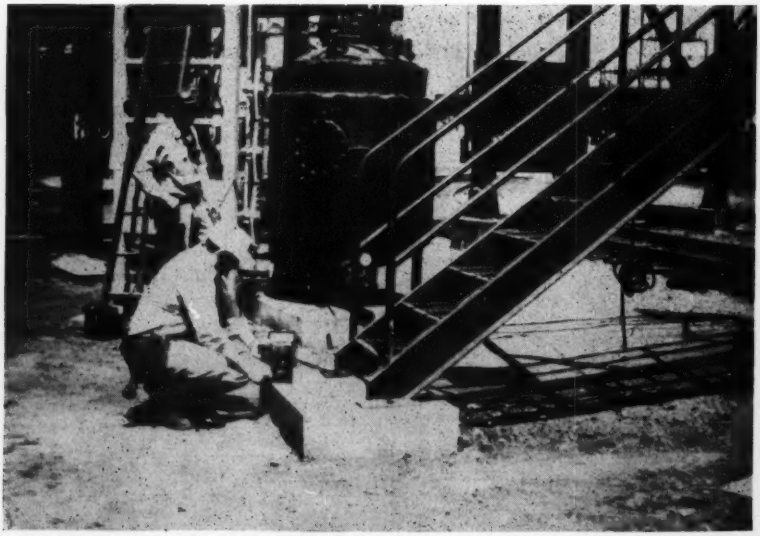
Tank car at unloading platform. This view shows a jumper with C-clamp for bonding the tank car to ground.


APPROVED GROUND CLAMPS AND BONDS OF 4 AWG EXTRA FLEXIBLE STRANDED COPPER CABLE
BONDS AT ALL GASKETED JOINTS
MAKE THIS CONNECTION BEFORE OPENING DOME
GROUND-CONNECT TO PIPE OR ROD
2 AWG BARE COPPER CABLE
WATER PIPE

Typical grounding arrangements for storage tanks and tank cars as established by the Engineering and Construction Division of American Cyanamid Company.

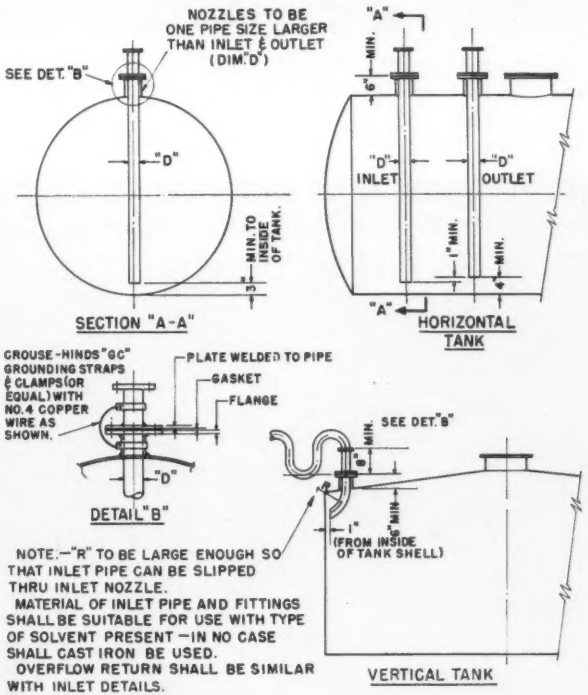


Megger method of determining the ground resistance of any structure as illustrated in an engineering instruction of American Cyanamid Company.

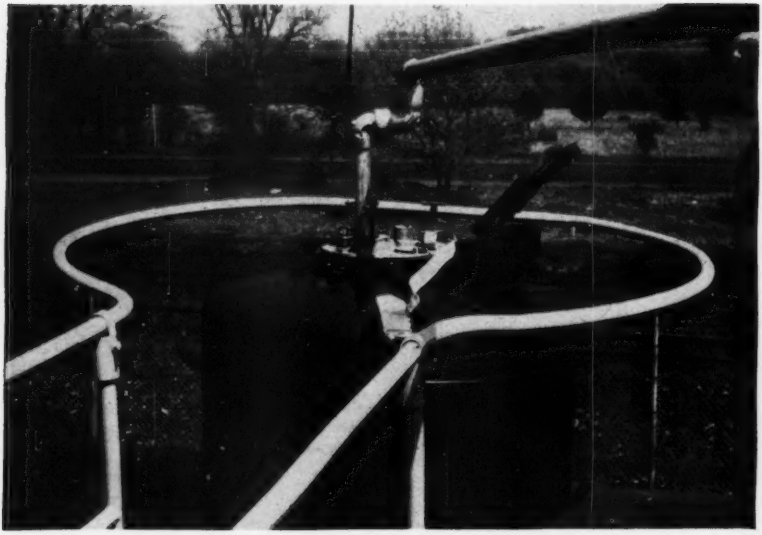


Electricians applying the megger method to determine resistance to ground at a tank car unloading station. High resistance is not tolerated and a reading of no resistance is generally secured. Where a resistance as low as 0.5 ohms is not obtained other arrangements are made.

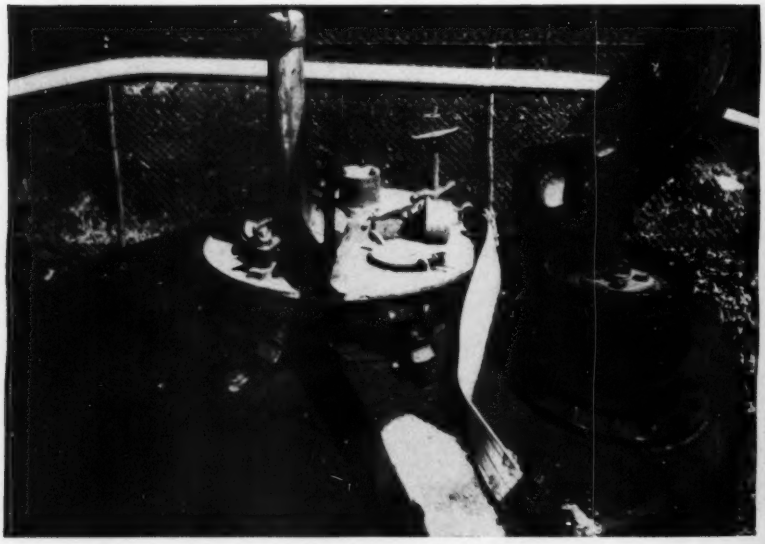
After the tank car has been spotted, the derail set and ground connections made, the unloading steps can then be taken. Here an operator is inserting a dip-leg made of magnesium metal into the tank car dome.



General requirements for the inlet and outlet arrangements on process and storage tanks for flammable solvents are outlined for company-wide use by the Engineering and Construction Division of American Cyanamid.

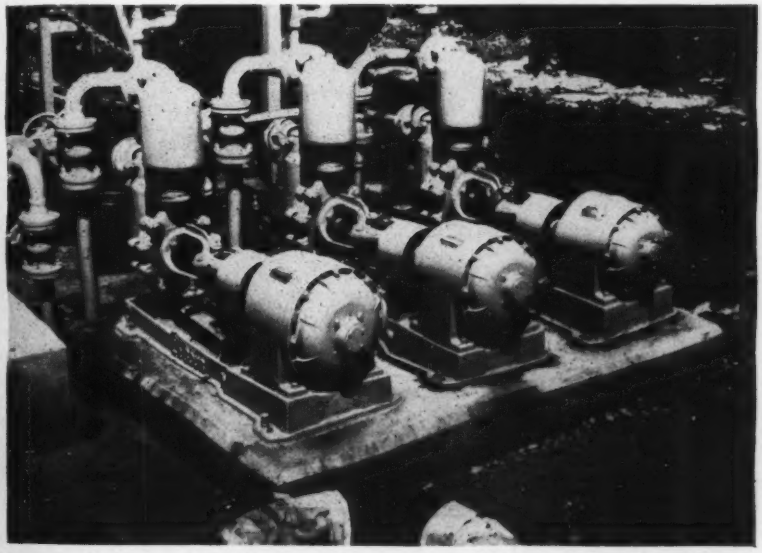


This shows the dome fitting and swing-joint connection in the unloading piping from the tank car platform.

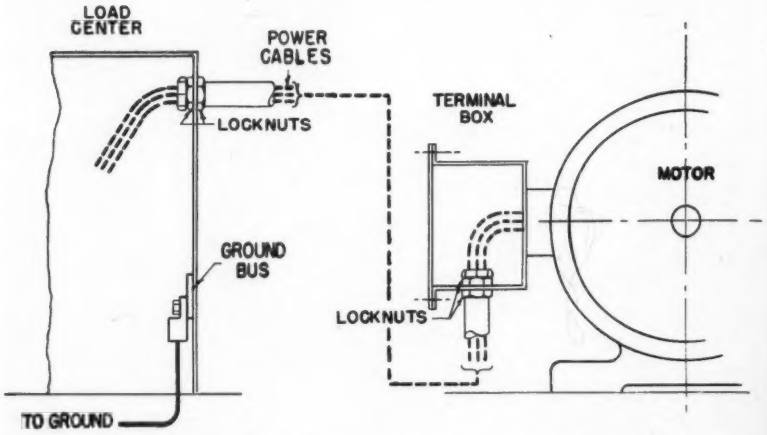


A closer view of the dome connection used in unloading a tank car. The dome fitting for the unloading connection is either aluminum or magnesium.

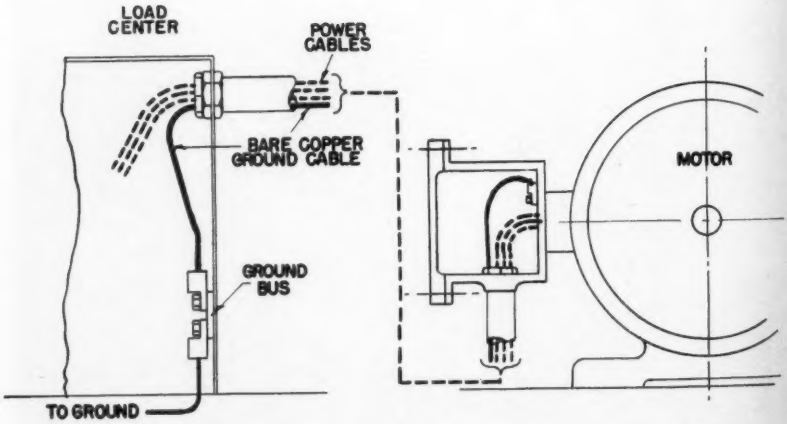
Electrical equipment at the tank car unloading station is designed for Class I, Group D, Division 1 locations as defined by the National Electrical Code. These are the line starters and switchgear accessories for the tank car unloading pumps.



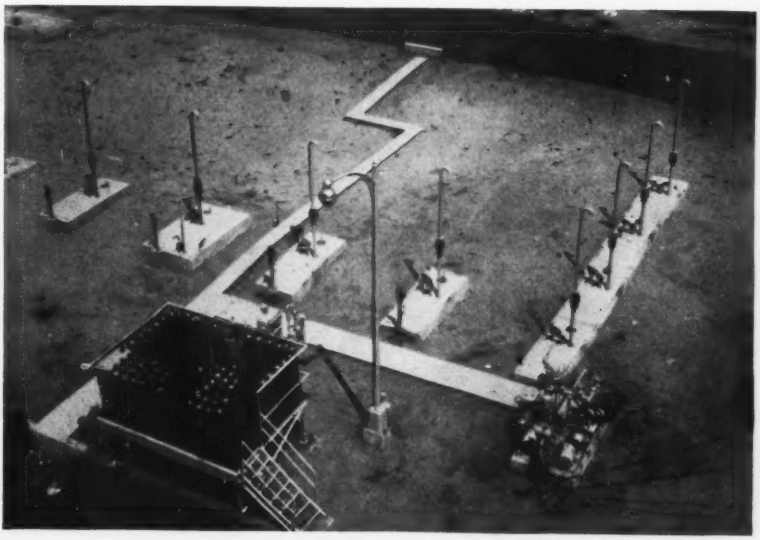
The electrically driven tank car unloading pumps at the tank car unloading site.



In non-corrosive atmospheres, the general arrangement for grounding electrical equipment is shown in a drawing issued by the Engineering and Construction Division of American Cyanamid Company.



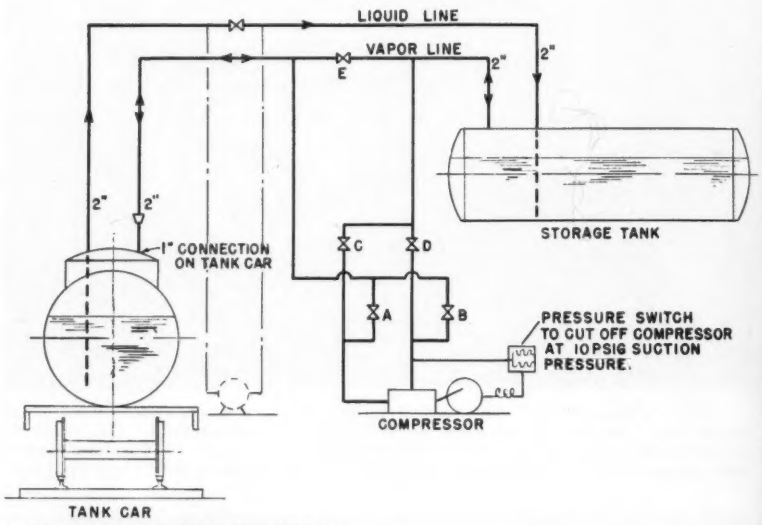
General arrangement of a grounding conductor in conduit for corrosive atmospheres or hazardous areas as outlined by the Engineering and Construction Division of American Cyanamid Company.



This is a general view of the farm of buried tanks to which flammable solvents are pumped from the tank car unloading platform shown in earlier pictures. This shows the concrete-protected pipe trench and the concrete panels which protect the individual tank fill and vent connections. The storage rack is for inert gas cylinders, nitrogen in this case.

A closer view of the concrete panels protecting fill and vent connections. The valves have indicators, brightly painted, which project up well above the concrete so that operating people will not easily be able to confuse valves which are open with those which are closed.

ETHYLENE OXIDE UNLOADING BY VAPOR COMPRESSION



UNLOAD LIQUID ETHYLENE OXIDE:

TAKE SUCTION ON STORAGE TANK VAPOR SPACE COMPRESS GAS—DISCHARGE TO VAPOR SPACE OF TANK CAR.

VALVE A — OPEN VALVE C — CLOSED
VALVE B — CLOSED VALVE D — OPEN
VALVE E — CLOSED

TO REMOVE VAPOR FROM TANK CAR:

CAUTION — DO NOT PULL TANK CAR DOWN BELOW 10 PSIG. THIS IS TO PREVENT A VACUUM OCCURRING IF TANK CAR TEMPERATURE SHOULD DROP GREATLY.

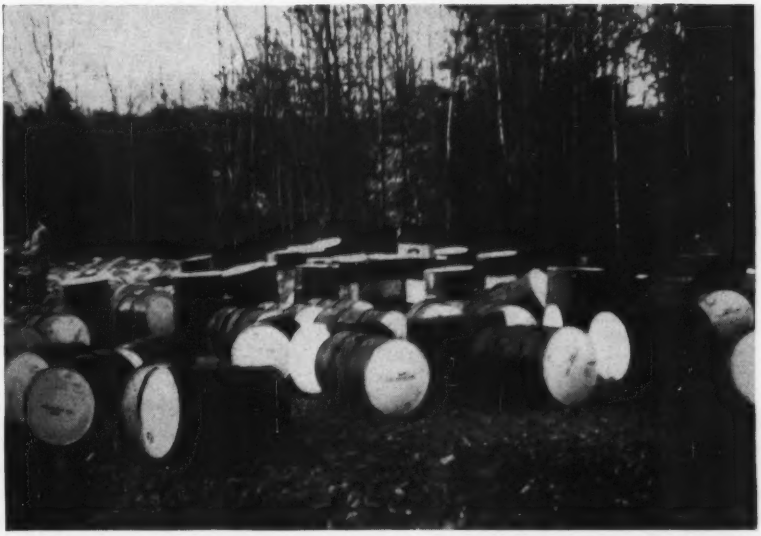
VALVE A — CLOSED VALVE C — OPEN
VALVE B — OPEN VALVE D — CLOSED
VALVE E — CLOSED

NOTES:

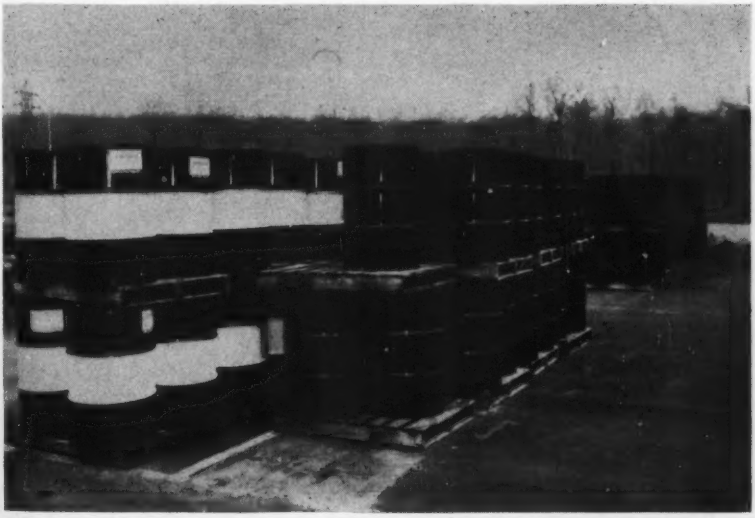
1. IF STORAGE TANK IS A CONSIDERABLE DISTANCE AWAY FROM TANK CAR, IT MAY BE NECESSARY TO INSTALL A CENTRIFUGAL PUMP IN THE LIQUID LINE THIS IS SHOWN DOTTED, IN ABOVE FLOW DIAGRAM.
2. VALVE E, USED ONLY TO EQUALIZE PRESSURES BETWEEN TANK CAR AND STORAGE TANK PRIOR TO UNLOADING, OPENED ONLY WHEN STORAGE TANK PRESSURE IS GREATER THAN TANK CAR PRESSURE.

SK-NY-5905A

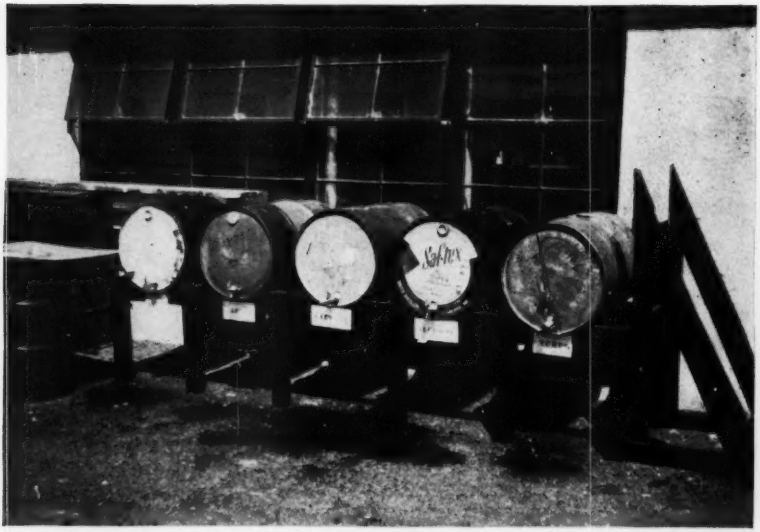
Diagram explaining the connections and techniques to be followed when unloading a material such as ethylene oxide by vapor compression (American Cyanamid Company drawing).



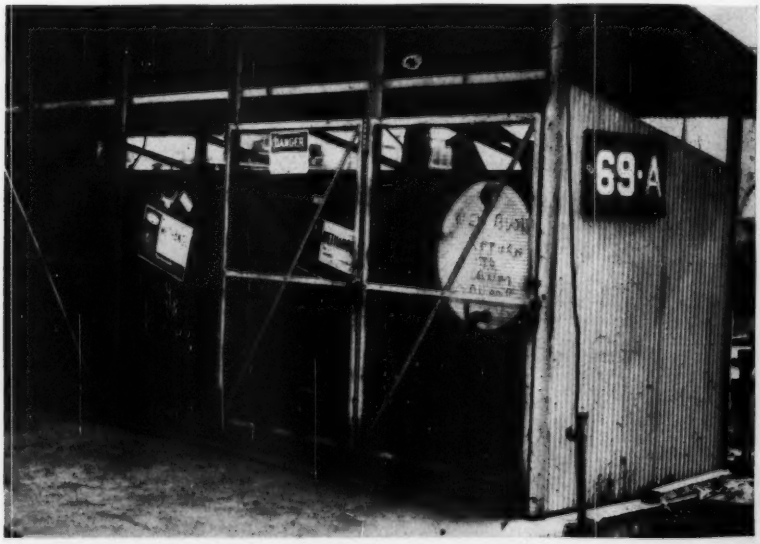
This is a picture of a very poorly arranged drum storage. Some of the drums here contain ether. Quite a few heads of drums so stored bulge, and some may blow off, when exposed to the heat of the sun as in the summer.



This is a somewhat better drum storage area. The drums are neatly stacked and the area is paved and drained.



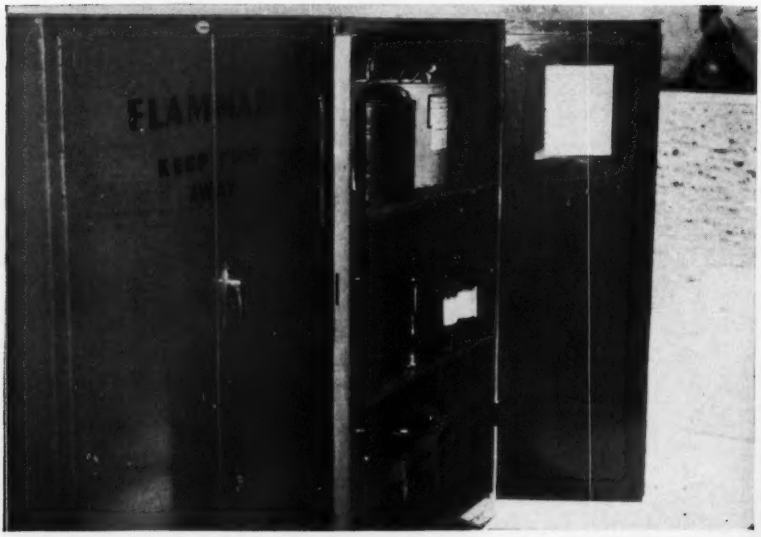
This is a flammable liquid rack which is neat and clean but that is all that can be said favorably about it. The drums expose a building of the plant through an unprotected window.



This is a much better arrangement of a flammable liquid rack. While some desirable features are lacking, it is at least located so as not to be a major exposure to other parts of the property and it is shaded and ventilated.

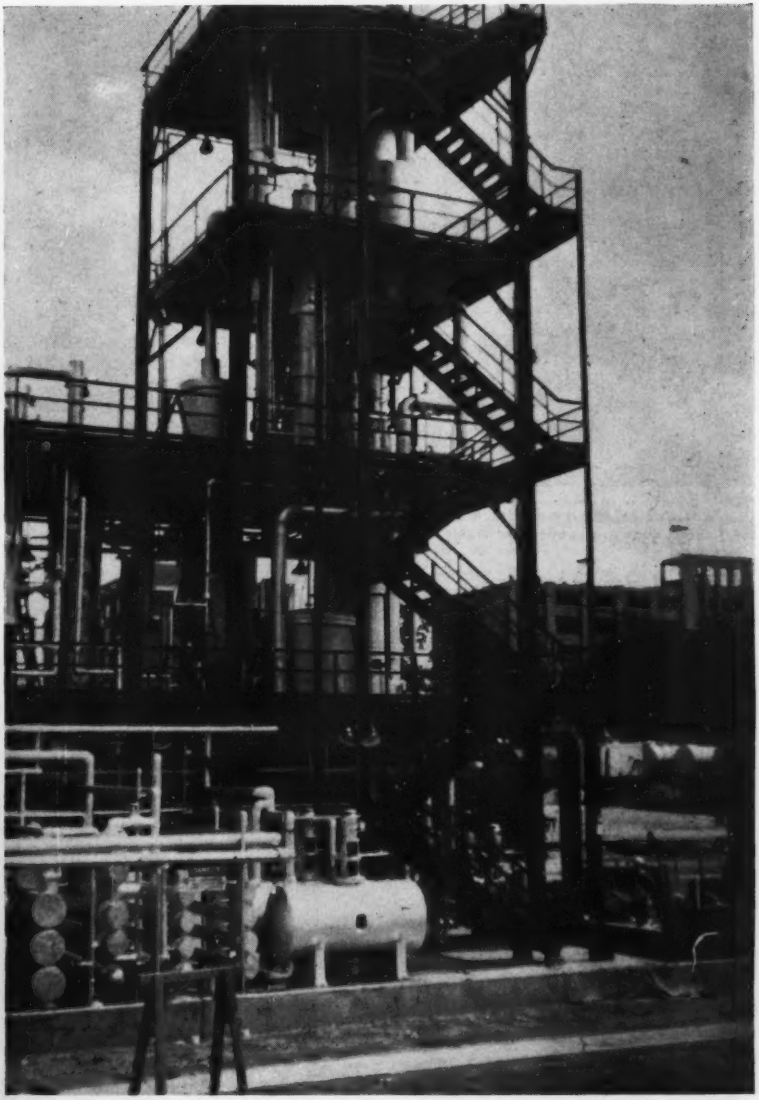
Here we have a dispenser transferring solvent from a drum to a safety can. The drum is bonded into a grounding system and the safety can is bonded to the drum.

Here is another arrangement of a dispenser transferring solvent from a drum to a safety can, in which the drum connection is in the head.



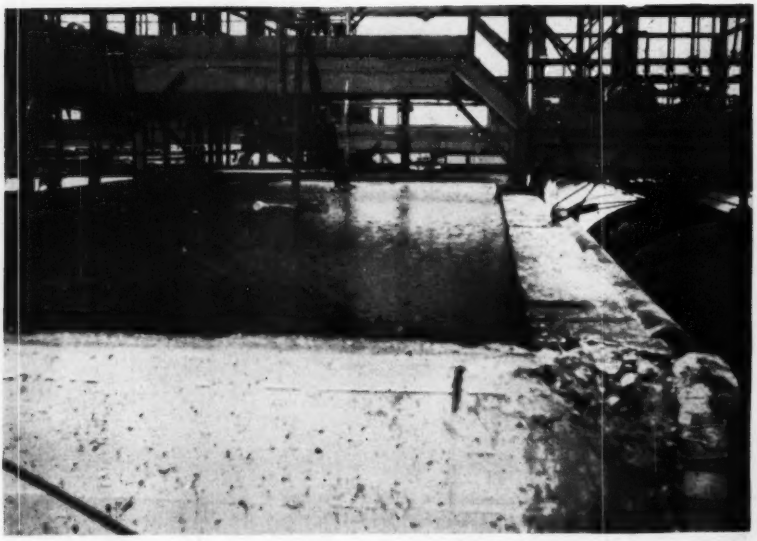
Steel cabinets are recommended for storage of small supplies of flammable liquids in bottles and cans.

Small quantities of flammable liquids which must be kept under refrigeration cannot be safely stored in the ordinary household refrigerator. Electrical features of such refrigerators such as the dome light and switch are possible sources of ignition of flammable vapors. This refrigerator has been rendered safe from these sources of ignition for the storage of anhydrous ether at a laboratory. One laboratory uses about 150 such refrigerators.



Stills or columns for the recovery of solvents used in a process are one of the common pieces of process apparatus involving flammable liquids. The one illustrated is used for the recovery of solvent from a turbo-drier.

Waste containers are needed not only for such things as broken glass, but also containers of a safety type are needed for waste solvents and for other flammable liquids.



Carbon disulfide is stored in a pit covered with water. This liquid is generally transferred from storage tank to process by water displacement, using either clear or salt water.

ROUTE TO
W.D.Holland
D.Edwards
C.H.Martin
S.F.Spence
H.A.VanBrocklin

AMERICAN Cyanamid COMPANY
AND SUBSIDIARIES

FIRE AND DAMAGE REPORT
(INCLUDING EXPLOSIONS, LIGHTNING, BOILER AND MACHINERY, ETC.)

PLANT Bridgeville DATE OF REPORT 4/5/56

DATE OF OCCURRENCE 4/5/56 TIME REPORTED: 10:00P.M. ☐ AM PM

LOCATION: BLDG. 6 FLOOR Main DEPT. P.A.A. SUPERVISOR C. Laughlin

ALARM BOX NO. 12A OR OTHER NOTIFICATION USED —

DISCOVERED BY L. Woodburn REPORTED BY C. Thomson

TIME FIRE ALARM SOUNDED 9:28 P.M. TIME FIRE EXTINGUISHED 9:32 P.M.

NUMBER OF PLANT FIRE BRIGADE MEMBERS ENGAGED 13

OUTSIDE ASSISTANCE None

DESCRIPTION OF OCCURRENCE Unit No. 36 was started at 6:00 P.M. A top head flange blew at 6:05 P.M. Both flanges were changed. Started to heat again at 8:00 P.M. At 9:28 P.M. the temperature was 410°C. and a fire started on the head of the converter.

REPORTED TO: No One FIA ☐ HARTFORD STEAM BOILER ☐ OFFICE _____ DATE _____

CAUSE Probably naphthalene had spilled out on top of the converter from the safety stacks when the flanges were changed. This fire was confined to a small area around one of the stacks (not the one which blew).

PREVENTIVE MEASURES TO BE TAKEN Check and clean tops of all converters and clean out safety stacks.

FIRE EXTINGUISHMENT EQUIPMENT USED One 30 lb. dry chemical and two 2-1/2 gal. foam.

NUMBER OF SPRINKLER HEADS OPENED None TIME SPRINKLER PROTECTION RESTORED _____

DESCRIBE ANY FAILURE OF FIRE PROTECTIVE EQUIPMENT One 30 lb. dry chemical failed to operate. The CO_2 cylinder had apparently already been punctured.

HAS ALL FIRE PROTECTIVE EQUIPMENT BEEN RESTORED FOR IMMEDIATE USE? Yes

INJURIES TO PERSONNEL None

SIGNED E. M. Highberger E. M. Highberger,
TITLE Night Superintendent

CDF-3483 PTD.IN U.S.A. 7/52

(Use Reverse Side for Preliminary Loss Report)

An important fire prevention procedure is the preparation of a fire damage report which company units are required to submit, whether there is a significant dollar loss or not. These reports give the circumstances of the occurrence and preventive measures suggested by the experience.

American Cyanamid Company
and Subsidiaries

Distribution:
General Office Management
Division Managers
Plant Managers
Plant Safety and Loss-
Prevention Supervisors

FIRE AND DAMAGE REPORT SUMMARY

Month of February, 1956

The following is an analysis of the Fire and Damage Reports for the above period according to cause. The losses indicated are the preliminary estimates of the direct damage only; they do not include Use and Occupancy.

CHEMICAL PROCESS - 5 losses TOTAL $ 52,900

Round Brook
Carbon disulfide escaped through a relief valve and burned in the stack and the overflow pan. Equipment is designed to handle such an occurrence and fire was extinguished without difficulty. 0

Damascus
Nitroso-clay press cake was being dried in a constant temperature dryer. After 23 hours drying it was discovered that the material had decomposed. Rapid oxidation due to temperature and free flow of air over the material is felt to be the cause of the decomposition. 400

Pearl River
A beaker of alcohol was being used instead of a non-flammable solvent to seal eggs. The alcohol ignited from a bunsen burner located nearby. 0

Warners
An explosion in a reactor vessel was caused by a runaway reaction. Improper amounts of chemicals is believed to have caused the reaction to overheat. 50,000

Welland
A sulphur dioxide blower
off the air supply and p
36-inch stainless steel

CHEMICAL SPILLS - 3 losses

Round Brook
Benzene vapors escaped t
ignited by the gas burne

Worn packing on the stir
become ignited on the ho

Pearl River
While transferring mash
of mash was lost through

- 2 -

CUTTING, WELDING, OPEN FLAMES - 2 losses TOTAL $ 0

Round Brook
Heat from a welding torch being used on the outside of a centrifuge caused the fresh paint on the inside to ignite. 0

Savannah
While a plate was being welded to the front of a fork lift truck, sparks set fire to excess grease on the lifting pistons. 0

ELECTRICAL - 4 losses TOTAL $ 6,045

Bridgeville
A 1000 HP electric motor driving a compressor failed during normal startup. The cause of the short circuit in the windings of the auto-transformer is presumed to be general deterioration brought on by high ambient temperature and high relative humidity. 1,790

Danbury
One phase of the power line coming into the sub-station broke at the connecting link causing an interruption to production. 100

Fort Worth
A reversing plug on a 150HP spray dryer motor arced to ground when the motor was being reversed. The cause is believed to be a loose contact in the plug which overheated and short circuited. 195

Fortier
A power interruption by the utility company caused the main refrigeration compressor to coast to rest. The electric motor driven oil pump stopped the flow of oil to the bearings allowing the bearings to be severely damaged. 4,000

EQUIPMENT FAILURE - 5 losses TOTAL $ 516

Round Brook
Raw material leaked out at seam of bottom head of an autoclave and ignited. During installation of the autoclave it had been found difficult to secure a good hydrostatic test on the bottom head. 0

Fortier
The raw gas compressor vibrated excessively and leaked oil. After investigation the cause was found to be soot deposit which unbalanced the rotor. 0

A previously brazed valve sleeve cracked allowing raw gas to leak into the cold box at nitrogen work unit. No fire resulted. 0

Pearl River
The drive shaft of a rotary blender sheared during normal operation causing the blender to stop. Metallurgical analysis is being made to determine cause. 500

Based on the individual loss reports, a monthly summary is prepared. The circulation of these summaries is very useful as a means of providing the information needed by supervisors and management in their efforts to operate without fire losses.

Testing for Fire Safety

By A. J. Steiner

Engineer, Fire Protection Department, Underwriters' Laboratories, Inc.

Testing for fire safety is for the purpose of protection of life and property against fire. Such testing can be divided into three categories:

1. Tests to develop regulations to reduce the cause of fire by controlling fire hazard.

2. Tests to determine efficiency of equipment and materials for the extinguishment of fire.

3. Tests whereby building construction and materials can be classified as to fire resistance and fire hazard.

If you will review proceedings of annual meetings of the NFPA for the last twenty or more years, you will find that the first two categories, namely, reduction of cause of fire and extinguishment of fire — receive an overwhelming amount of attention in comparison with building construction. The Committee on Building Construction is not a prime mover in the development of "engineering practices" for use by regulatory bodies, and as a result, this work has been carried on by other organizations whose primary interests are not fire protection. What I am trying to say is that organizations which promulgate standards for fire tests and classification of building materials and structures are not primarily interested in fire protection.

Ancient history tells us of large conflagrations which destroyed cities. Modern United States history tells us of large conflagrations in places like New York City in 1835, which was a $15,000,000 fire; the St. Louis fire in 1849 had a loss of 425 buildings and $5,000,000 in property; City of Chicago in 1871, a loss of over 17,000 buildings and property loss of $200,000,000 and 400 lives; Boston in 1872, with a loss of 776 buildings and $75,000,000; and during this century, large losses in Baltimore and San Francisco fires among others. These and many other fires caused men of foresight to organize forces to combat mass fire destruction.

The NBFU Building Code

In 1896, the National Board of Fire Underwriters drew up a model building law which undoubtedly is the origin of modern building codes. The NBFU also aided in organizing the NFPA and Underwriters' Laboratories. This was the first organized technical and scientific effort made to reduce fire losses. Of course, mass fires continue, but fire areas, that is, the number of buildings in a given fire, are reducing. Modern technical developments are producing enormous life and property losses in single buildings or structures, as exemplified by fires such as Livonia, LaSalle Hotel, and Boston nightclub, as well as losses in dwellings of modern construction, which may be attributed to the lack of proper building construction precautions and regulations from a fire protection viewpoint. It is not necessary to elaborate on the many fires which are occurring; a survey of the NFPA *Quarterlies* and releases by the National Board of Fire Underwriters speak for themselves. These fires indicate, in my humble opinion, the lack of recognition of progress in fire protection made in the last fifty or more years.

Are we using the science of fire protection in building regulations which

This paper was presented at the Fall Conference of the National Fire Protection Association, Hotel Statler, St. Louis, Missouri, November 28, 1956.

allow the construction of large glass and similar unprotected areas in combination with material of unknown combustibility and fire performance, in modern buildings especially where congested personnel and hazardous processes exist, and permit homes to be built of materials which spread flames so rapidly that loss of life is a common occurrence? The results caused by errors in fire protection have been pinpointed in such fires as previously mentioned, and are waiting to occur again in the promiscuous use of building materials. Unless the fire protection fraternity takes an active part in developing realistic regulations which are acceptable as building laws, we can expect continued large losses of life and property.

NFPA Committee on Devices and Materials

The early efforts in building regulations were on the construction basis, which were governed by field experience. Under such regulations, for example, a fire wall was required to be of substantial thickness of brick, stone, or concrete, because it could withstand considerable fire and retain its stability and prevent spread of fire. A fire door was required to have rigidity and strength, limited in size, and provided with massive hardware. Windows required shutters. Building materials used were simple; they were either combustible or noncombustible, such as wood, stone, or iron. Naturally, with the development of new materials and new methods of construction the need for interpretations as to the behavior under fire exposure conditions arose and prompted the organization of NFPA Committee on Devices and Materials, and because of the great strides in development of new products, Underwriters' Laboratories was started as a testing organization for the classification of all kinds of devices and materials, including building materials and structures. With the assistance and guidance of the NFPA Committee on Devices and Materials, the National Board of Fire Underwriters, fire insurance rating bureaus, the fire tests developed at Underwriters' Laboratories were based on the views and interpretations of those primarily interested in fire protection on the basis of past experience.

Interest in Fire Testing

Interest in fire testing grew not only in this country but also in others. In the 1890's a series of fire tests was conducted on building structures in England. This interest has been recently revived. Similarly, a series of fire tests was conducted at Columbia University, and during 1915 to 1925 a series of column tests was conducted in a cooperative program by the Factory Mutuals, National Board of Fire Underwriters, and the National Bureau of Standards at Underwriters' Laboratories. Fire tests were being conducted at various places. Because of conflicting interpretation of results due to variation in test procedures, a committee of the American Society of Testing Materials was organized in the interest of uniformity to standardize on the fire test procedure for building structures. Since 1920, test equipment has been erected at the National Bureau of Standards and at some universities as well as in a number of foreign countries. Testing facilities have grown, and test results are being presented for building regulations strictly on test basis without regard to proper interpretation from a fire protection viewpoint. The personnel of the ASTM Committee on Fire Tests is not in the hands of those primarily interested in fire protection.

Fire Tests Not Sufficient

What I am trying to say is that fire test results only are not sufficient to establish fire protection engineering practices just as the strength test results of materials are not sufficient to establish structural engineering practices. In a given building, a structural engineer or someone qualified is required to establish proper design so that the structure

will be sound. Similarly, someone qualified is required to establish fire protection design so that the structure will provide the desired fire protection. From my observations, the responsibilities in fire protection are being assumed by various groups because no one group has assumed responsibility for regulating building construction from a fire protection viewpoint.

Since the origin of the National Building Code in 1904, in which year the Baltimore $50,000,000 and Toronto $12,000,000 fires occurred, many building codes have been written. Many large cities and a number of states have prepared building codes, and organizations in different areas of the countries have prepared building codes for use by municipalities in areas served by them, and all of these codes consider fire protection details based to a considerable degree on their own concepts. Considerable variations develop because the writers of these codes have different ideas in regard to the suitability of constructions for fire protection, and some of these variations can be traced to the change-over from construction type codes which were developed on the basis of field experience, to the performance type code which is based on test results and misinterpretation of fire test results.

A Good Push

For example, nearly all building codes require 4-hr rating for fire walls. As fire protection people, we are all aware that one of the properties for fire walls is that in addition to the 4-hr fire resistance rating, developed by standard test methods, a certain amount of stability is needed. Such properties are not expressed by present fire tests. With progress made in insulation properties of materials it is possible to rate a 4-hr wall on insulation basis, but the wall may not have sufficient stability to qualify as a fire wall. We have seen building structures so fragile that a good push would collapse them after the fire-retardant rating has been earned.

The building regulations based only on performance as developed by fire tests were intended to eliminate confusion, and are now causing it for the following reasons:

1. The misinterpretation of test results.

2. The use of tests which do not develop data intended for material as used in buildings.

3. The lack of enforcement in the construction of assemblies as to the properties of the materials and method of assembly described in the report of tests.

Proper interpretation of test results requires knowledge of fire protection problems. It is not sufficient to accept test results without knowing their meaning or how to use them.

Standard Fire Tests

The standardized fire test procedure for structures is popularly referred to as the Standard Fire Test Specifications or ASTM-E119 or NFPA No. 251. Fire tests are now generally sponsored by producers of building materials. When the results of the tests are presented to building officials, insurance engineers, and fire department chiefs, the sponsor naturally emphasizes his product and its use in the construction producing the given classification but not necessarily from a fire protection viewpoint, nor that the method of assembly be confined to that used in the assembly tested. We know that structures of the same materials applied by different methods produce different time ratings. For example, the same type of wallboard applied in a different manner in the construction of a wall may produce from ½ to 2 hours in fire retardant classification. Concrete used in different designs of floors and walls varies from 1 to 4 hours with only the difference in the type of aggregate used and distribution of materials.

Variation in Results

Just a few weeks ago, a manufacturer of ⅝-in. wallboard, which is labeled by Underwriters' Laboratories, requested a change in the formulation of the core. The ingredients composing the core were the same, the desire was to change only the properties of the ingredients. For all practical purposes the board was just like any other board, but results in fire tests did not qualify the product for the same classification as for boards which have not changed. Building blocks of the same size made of the same kind of aggregate but with variations in weight produce fire-retardant classifications varying 100 per cent or more.

These examples show that from a fire protection consideration, the fire ratings are dependent on details of methods of assembly, and the properties of the materials used must be specific in character, which many times cannot be identified except by inspection during the course of erection or manufacture. Such identification on building products is provided by Underwriters' Laboratories' inspection service established in the interest of fire protection. The rating for structures recorded in a report is worthless as related to similar structures in an actual building unless the materials used and the method of assembly is the same as used in the test assembly. It is my experience that the authorities require certain thickness of plaster, concrete, and wallboard to provide a given fire rating. This is fallacious, because if the product does not have specific properties and is not assembled in a given manner, the ratings may vary as much as 100 to 200 per cent; but, and this is a big "but" — assemblies of the same fire rating are not necessarily suitable for use for all locations.

To obtain the fire protection desired in buildings, the following must be determined from the test data:

1. Is the fire test conducted in accordance with accepted standards for building materials?

2. Is the construction suitable for use in a given location?

3. Is the construction on the job the same as that tested?

4. Do the materials used have the same properties as those used in test?

Two Kinds of Fire Tests

The standardized fire tests for building constructions conducted to develop fire classifications or ratings are of two kinds. The first is the fire-resistance rating in terms of time for walls, columns, floors, ceilings, doors, and windows as developed at Underwriters' Laboratories, now identified as NFPA No. 251 and ASTM Spec E119. The second is the fire hazard classification for building materials conducted to develop ratings for flame spread, fuel contributed and smoke developed for materials used as interior finishes, acoustical, decorative, as well as insulation purposes, also developed by Underwriters' Laboratories, as the tunnel test, now identified as NFPA No. 255 and ASTM E84.

In considering the first, that is, fire retardant ratings for building structures, on a time basis, the test procedure can be divided into three kinds, namely,

1. Test on walls, partitions, floors, and roofs, for which the time rating indicates the period they will protect against passage of flame and excessive heat from the area the fire starts to adjacent areas without regard to stability of the assembly after fire exposure nor whether the materials used in the structures are combustible or noncombustible.

2. Tests of columns and beams for which the time rating indicates the period these members are capable of carrying their assigned load pro-

vided the fireproofing is not dislodged by falling of other building members during the fire.

3. Tests of doors, windows, glass blocks, and any other protectives for openings in buildings for which the time rating indicates the period they will remain in position without permitting flames to pass.

The severity of fire used in all tests for fire retardant rating is the same, that is, the exposing fire reaches 1000°F. in five minutes and gradually increases to 1700°F. in one hour to 2000°F. in four hours, but the test results which establish the ratings are different.

Testing Walls and Partitions

The first kind of fire retardant rating is the standard fire test for walls and partitions, floor, and roof, in which the samples are at least 100 sq. ft. in area for walls and partitions and 180 sq. ft. for floors and roofs. In both cases, the test assemblies are built in a manner to represent actual conditions of construction, that is, the walls may be load bearing or non-load bearing, but restrained the same as in a building. In the case of floors and roofs the edges are restrained while carrying the load for which they are designed. One face of these assemblies is exposed to fire and the rating represents the time these structures are capable of preventing the fire passing through them or when the unexposed surface records a temperature increase of 250°F. average over the surface or 325°F. at any one point above the temperature at the time the test is started or local distortion which will permit ignition of cotton waste. With the present-day popular unsymmetrical walls of the laminated or sandwich type, it may require that the fire rating be developed on the basis of exposure to each face.

During the test, observations are made of the behavior of the structure including deflections, but these are not considered significant as long as the assembly is capable of carrying its load (when required), provided the distortion does not develop local openings which will permit sufficient flame or heat to penetrate to ignite cotton waste or limiting temperatures are not reached. It may be well to again repeat that the problem confronting those interested in fire protection is the stability of the structure during and after the fire exposure as well as the temperature transmission which is now the primary basis for rating. Therefore, to establish regulation, it is essential that the data developed by the Standard Fire Test specifications be properly interpreted in relation to the needs from a fire protection viewpoint.

Testing Columns and Beams

The second kind of fire-retardant rating is the standard fire test for columns and beams. The ratings are based on failure to carry the designed load. At least 8 ft. of the column is exposed to fire, while in a beam at least 12 ft. is exposed. The columns are exposed to fire on all faces, while in the test of beams the exposure varies depending on how it is used. In some cases, where the beam is protected by a suspended ceiling, the rating is dependent upon the construction surrounding the beam. These tests can be conducted without load applied when the end point or fire-retardant rating is established on temperatures basis of 1000°F. average at any cross-sectional area, or 1200°F. at any one point recorded by thermocouples placed in standard locations. This does not mean that all beams and columns can be tested without applied load, but only those in which the load carrying material is effectively related to the end-point temperatures. There are some discussions to develop the fire resistance ratings for pre-stressed beams and slabs, about which very little, if any, fire performance information is available. Questions are being raised whether existing standard test procedures are sufficient, especially in regard to length of the beam and whether temperature of the load supporting tension wires are significant in establish-

ing a rating. There is need for information on the performance of such beams under fire exposure conditions before fire ratings can be assigned.

Errors in Interpreting Tests

It must be remembered that fire ratings are based on structures as tested; that is, the combination of specific materials assembled in a specific manner. It should not be necessary to say this, but it is worthwhile to repeat, the same material assembled in different manner will result in different fire ratings; for example, the fire ratings of steel structural members protected by plaster will vary dependent on the thickness and type of plaster as well as space provided between the fireproofing and the structural member. One of the common errors in interpreting fire rating of beams in combination with floors and ceilings is the reduction of spaces between the suspended plastered ceiling and the load-bearing members and the cutting of openings in the plaster for installation of lighting fixtures and other utilities.

Test for Doors and Windows

The third kind of fire retardant rating is the standard fire test for doors, windows, glass blocks, and other opening protectives. Considerable misunderstanding exists in regulations for opening protection.

It may be of historical interest to acquaint you with the fact that until the last few years all doors were tested for 1 hour and windows for ¾ hour, and the ratings were not on a time basis but rather on basis of specific designs for use in certain locations agreed upon by those interested in fire protection such as NFPA and NBFU as recorded in Standard No. 80, Protection of Openings.

In recent years, the writers of building codes specified doors and windows on a time basis. The first of these codes was that of New York City, which was written when time ratings for doors did not exist. Because the New York market is so great, door manufacturers requested tests to qualify them in the New York area. Because no fire protection group appeared to take any interest, Underwriters' Laboratories had to go along. I remember the first 3-hour fire test on a steel rolling type door. After the usual 1-hour fire exposure it was like sitting around an overheated pot-belly stove. Our Laboratory was hot for many hours after the test, but no additional information was developed from a fire protection point of view.

Trend for Time Ratings

The trend for time ratings increased, and to assist the desires of building code writers as well as insurance interests the test procedure developed by Underwriters' Laboratories has been adopted as ASTM Standard E152, and later adopted as NFPA Standard No. 252, and now doors are classified on a time basis. Again, classification interpretation is needed by those primarily interested in fire protection. The present Standard No. 80 states that openings in fire walls be protected by a fire door intended for fire walls on each face of the opening. This was changed by code writers to require one 3-hour door, or a 1½-hour door on each face of the wall, without any regard to heat transmission or hardware details. The question of heat transmission through doors has been bounced around like a rubber ball. Most building codes assume erroniously that the time rating on doors is the same as the time rating on walls and partitions, which, of course, is not correct. To provide information about the performance of doors in fire tests, Underwriters' Laboratories has during the past year changed their label to show the time rating, place or location the door is intended to be used based on past classifications, plus temperature developed at the end of 30 minutes of test. For example, a label may read—"3 hours (A) — 250°F. at 30 min." The time rating, location and tempera-

ture may vary. Someone must establish where certain classification should be used. It is my hope that Standard No. 80, which is now being revised, will provide the needed interpretation. This is another example of the secondary position taken by organizations primarily interested in fire protection to guide in the promulgation of fire protection regulations.

Windows and Glass Blocks

Windows and glass blocks have been and are all tested for ¾ hour because glass softens and begins to run at a temperature of about 1638°F., which is reached at ¾ hour on a standard time temperature curve. The test procedure has only recently been reintroduced to the ASTM Committee, but has not yet been adopted because the window industry has in the past objected, but has proceeded to obtain acceptance of fire windows on a construction specification basis in building codes which pride themselves as being performance codes rather than on fire performance basis. Also, the requirements for fire window openings as recorded in Standard No. 80 are being grossly neglected by those who are looked to for guidance in fire protection problems. This is another example of the lack of proper guidance by those interested in fire protection.

The severity of fire exposure during tests of doors and windows is the same as used for walls, columns, floors, and beams, but the classification is based on their ability to remain in position and to keep the fire from passing through the opening which they are designed to protect, as well as their ability to resist hose stream after the fire exposure. To provide realistic comparison of test results with actual performance in field fires, the test assembly must be representative of actual installation, and of the largest size intended to be used in the field. For doors, the performance depends, in addition to design, on the type of frame and hardware used, and also on the clearances between doors and frames. For windows, the test assembly must include the various kinds of sash, namely, swinging, pivoted, or casement sash, with proper hardware and provisions for expansion so that the metal parts and the glass act as a unit, and resist separation and formation of opening as a result of fire exposure and hose stream. For glass blocks, in addition to the design, the kind of mortar and expansion joints play a significant part in the fire and hose stream performance.

As in the case of walls, floors, columns, the design and installation of doors and windows as tested plays an important part in the fire performance. Therefore it is also essential that similar precautions be taken in the field if the ratings or classification established by test are anticipated.

I believe it is worth while repeating that the time ratings for doors do not have the same significance as those obtained for walls and floors, and in all cases I wish to emphasize that in all cases doors at the present time will permit heat passage greater than walls and floors for the same time classification.

In the case of windows and glass blocks, no measure of heat passage is considered. Here again code writers assume that because windows are tested for ¾ hour, the classification is the same as a ¾ hour wall. Remember, the primary purpose of a door, window, and other opening protective is that it remain in position during fire exposure and hose stream.

Flame Spread Tests

The second division in fire ratings is the fire hazard or flame spread rating of materials which in comparison with the fire tests previously discussed is relatively new.

During the last two decades or more, we have heard considerable discussion of the flame spread of building materials. These hazards have been created by new materials and combination of materials which are used for decorative,

insulation, and acoustical purposes or interior finishes applied to structures. It is not uncommon to hear of flash fire and it is not uncommon to hear of fire resistant commercial buildings and homes having a fire in which lives are lost due to rapid flame spread. A building which is structurally fire resistant or "fireproof" can become an inferno due to finish applied on walls and ceilings in the form of acoustical or decorative tile and wall paneling, as well as insulation. A structure may resist total burnout and remain structurally sound but a number of lives may have been lost because of rapid spread of flames of fierce burning materials applied to the interior surfaces. You of course have been confronted by producers of the materials which spread fire rapidly by the statement that the loss of life in such fire was due to the lack of provision of the proper number or kind of exits, or non-conformance with building regulations.

The question of flame spread on building materials has been with us for centuries. Early history of the Egyptians records concern about flame spread on wooden structures and ships. Back in the early 1900's, Underwriters' Laboratories listed a number of so-called fireproof paints. Some of you may remember the special insurance credit given to such coatings as well as to whitewash on wooden structures, but these were dropped primarily because the fire protection gained was not in the coating but by good housekeeping resulting at the time structure was painted.

"Fireproof" Paints

In 1921, Underwriters' Laboratories was again asked to classify another "fireproof" paint which was claimed to eliminate burning of wood building structures. I recall it was one of the first complete assignments dropped into my lap. The proponent showed photographs of a demonstration of two boxcars which were on adjacent tracks, also two miniature wooden houses placed side-by-side with a small space between them, and a fire started between the boxcars and the houses. The boxcar and house painted with the "fireproof" paint remained intact, while the others were entirely consumed. Such demonstrations are very convincing, but my problem was to show the value of the paint under controlled fire conditions. With the Laboratories' background with "fireproof" paints we were skeptical.

During the investigation the idea of the present tunnel test or fire hazard classification for building materials had germinated, and it showed that the fireproof paint was not better than cold water paint so popular at that time, and the subject was dropped. Later, development of pressure-impregnated "fireproof" lumber came into popularity. The New York City Building Code in the early 20's required that in buildings over certain stories in height, all wood trim had to be fireproofed. Underwriters' Laboratories was requested to investigate the efficiency and to establish a classification. There existed a number of tests for "fireproof" wood such as the New York Crib Test, Timber Test and Shaving Tests as used by Columbia University to assist New York City authorities to determine acceptance of treated lumber. Also, the Forest Products Laboratories devised the present fire tube test. These tests provided a means to show a well-treated product from a poorly-treated product, but did not provide a means for classification showing the difference between different kinds of treatment and depth of penetration of each treatment. Some of the above-mentioned tests are now ASTM fire tests for treated lumber.

The Tunnel Test

When Underwriters' Laboratories investigated treated lumber, tests were conducted by all existing methods and a newly designed tunnel test. The results of this investigation were recorded in 1935 in the first report of its kind on the efficiency of treated lumber in com-

parison with untreated lumber. This investigation led to the development of the present tunnel test, which provides a basis for the classification of building materials as to flame spread, fuel contributed, and smoke developed and was adopted by ASTM as Tentative Specification E84 about five years ago, and by NFPA as Standard No. 255 only last year. The NFPA Committee on Safety to Life had been struggling with the fire spread problem for many years, and it has finally been instrumental in the adoption of the test by the Committee on Fire Tests.

The tunnel test is used to classify all building materials as to their burning characteristics. The sample consists of a surface 25 ft. long, 20 in. wide, attached to the removable top of the tunnel-shaped furnace in the manner in which the material is used in actual field practice as an interior finish. The exposing fire consists of flame applied to one end and a draft carries the flame down the tunnel approximately 4½ ft. If the material being tested is combustible at all, the flame will travel down along the test surface, and the rate at which it spreads or the distance it will spread establishes the classification number for the flame spread hazard of that material. Data is also taken to classify the density of the smoke development and fuel contributed by the material under investigation, and information can be obtained on the toxicity of the products of combustion.

Basis for Classification

The basis for the classification is that a product made of asbestos and cement is rated as zero for flame spread, fuel contributed and smoke developed, and red oak wood is classified as 100 in each of the categories. Under the standardized test conditions it takes approximately 5½ minutes for the flame to travel down the full length of the 20 ft. oak surface. If the flame spreads all the way in half the time it is classified as 200, or if only half as far then the material classifies as 50. This test, therefore, provides a yardstick for measuring the flame spread characteristics of various types of building materials.

Classifications by this test method have been developed by Underwriters' Laboratories for nearly all types of products used in building construction.

Although the question of burning characteristics of building material is and has been important to the fire protection engineer, he has not taken an active part in the establishment of the classification, possibly because the simple classification that a material is either combustible or noncombustible is more convenient. If we go on the assumption that wood is combustible, then how do you classify material made of wood or cellulose fiber in the form of soft and hard vegetable fiberboards and some plywood which will burn more rapidly than wood itself, and material made of wood combined with noncombustible cements which will not burn rapidly? Also, how are products like plastics and asphalts in combination with noncombustible material to be considered?

Plastics

In recent years the use of plastics has grown from tool handles, toys, decorations, dishes, and the like, to use as a building material for windows, skylights, partitions, ceilings, and decorative purposes — therefore it is of interest to fire protection people to compare them with the burning characteristics of other building materials.

During the early days, plastics appeared as a raw material in manufacturing plants. The fire protection groups interested in reduction of cause of fire, not the Committee on Fire Tests, classified and compared the burning characteristics of different kinds of plastics; also Underwriters' Laboratories prepared Research Bulletin No. 22, dated 1941, on the same basis. These classifications used terms such as slow-burning, self-extinguishing, thermo-setting

and thermo-plastic as recorded by tests D568, D635, and D758 developed some fifteen years ago by ASTM Committee on Plastics. When plastics were introduced as light diffusers in electric lighting fixtures and signs, the same kind of tests were used by the electrical groups. Now that plastics are being used as building materials, the same test method and classifications are used by the plastic industry in promoting plastic in building structures.

The producers continued to promote the use of their wares without any significant reference to the performance in fire, nevertheless this group has prepared a chapter on plastics for adoption in building codes. This is another example of groups not primarily interested in fire protection writing regulations. Nevertheless, because of the need for classifying materials as to flame spread characteristics, Underwriters' Laboratories is classifying plastics on the same basis as any other building material used for interior finish. The use of plastics is growing, and the plastic producers and fabricators are prescribing fire protection requirements rather than people primarily concerned with fire protection.

The tests which classify plastics as self-extinguishing and slow-burning do not correlate with the Fire Hazard Classification. To illustrate, some time ago a plastic which had been classified as slow-burning was subjected to the tunnel test and the results were disastrous. The material burned so fiercely and created so much smoke and molten residue that it took days to clean up and repair our furnace. Need for action by a fire protection group is essential to control the fire hazard being created.

Conclusion

I have discussed with you very briefly some of the fire test procedures. I also attempted to impress on you that tests, to have any significance, must be properly interpreted. The value of results of a test are dependent on the details of material and methods used in the test assembly. The value of results of a test are dependent on how these details are used for compliance with requirements in enforcing building laws or codes. The value of results of a test are dependent on their significance as related to their use, based on actual field fire experience.

When fires in which large losses of life and property continue to occur, it is an indication that our knowledge in fire protection is not fully utilized. When daily newspaper headlines continue to record the loss of lives in homes and industrial occupancies by fire, it is very evident that with the ever-increasing development of new materials in this chemical and atomic age, the same kind of forces which organized the NFPA and Underwriters' Laboratories must again recognize the dangerous trends in the development of even greater fire hazards. If the fire protection forces do not again take the same interest as they did at the turn of this century, even greater losses of life and property can be anticipated.

Heavy Timber Construction

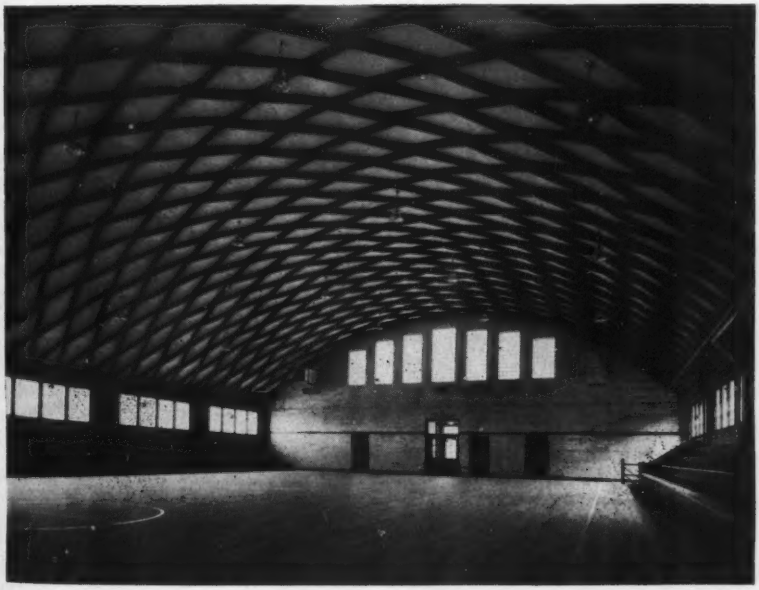
By Frank J. Hanrahan

Executive Vice-President, American Institute of Timber Construction

Heavy timber construction has been in continuous use for many centuries. The temple of Solomon, containing timbers from the tall cedars of Lebanon, was of heavy timber construction. Early American buildings had hewn beams and heavy floors. Its excellent performance in fires over centuries of experience has firmly established the great value of heavy timber construction in reducing fire hazard to life and property. Because of its fire experience record, the term "slow-burning" became synonymous with it.

This article based on a talk presented at the 59th NFPA Annual Meeting held in Cincinnati, Ohio, May 16–20, 1955. — Ed.

There has been much recent technical progress in engineered heavy timber construction. One advance has been through the use of glued laminated lumber structural elements, comprised of relatively small pieces of lumber bonded into single units of great strength which can be practically of any size or shape. An improved method of framing both sawn and glued laminated lumber has been another achievement brought about through the use of more efficient fastening methods. A third reason for progress is the ingenious engineering accomplished by the recently established structural timber fabricating industry and by others. These developments have freed timber



Eighty-five ft. span timber lamella roof on gymnasium at St. Charles, Mo.

250 ft clear span glued laminated timber bowstring trusses spaced 25 ft. apart with 6 in. by 14 in. purlins, 2 in. plank, and 11 in. by 18 in. wood columns. The building is at the Westchester County Airport (N. Y.) and provides three 250 ft. by 150 ft. by 30 ft. clear height hangars.

construction from restrictions of short spans and straight pieces formerly imposed by available sizes of sawn lumber for simple beam-and-post construction.

With the wider applications of heavy timber construction made possible by modern techniques, there has been no loss in its structural and fire resistive attributes. Engineered timber construction is now widely used in churches, schools, places of public assembly, military installations, warehouses, stores, and many other commercial, industrial, and agricultural structures. There is a wide range of constructions using heavy timber sections conforming to the traditional fire protection standards covering heavy timber construction.* If the true fire safety provided by heavy timber construction were more adequately recognized by building officials (through larger permissible building areas in building codes) and by fire protection authorities (including fire insurance rating organizations through lower relative insurance rates), there would be more incentive to use heavier timber structural elements and more attention would be given to details which would increase the fire resistance rating of timber construction. In many cases conversion could be made with relatively minor changes or variations in the design such as by the use of purlins and roof planks in place of joists and one-inch sheathing.

*See NFPA No. 220, Standard Types of Building Construction, published in National Fire Codes, Volume III and in separate pamphlet form.

The NFPA text on" Standard Types of Building Construction" (No. 220), in the section covering heavy timber construction, calls for minimum nominal timber sections in the order of 8 inches by 8 inches for columns, 6 inches by 10 inches for beams and girders, 6 inches by 6 inches for roof beams or girders, 4 inches by 6 inches for roof framing members, and roof deck plank of not less than 2 inches thickness, with variations permitted under certain conditions. When columns, beams, girders, and trusses of other than wood are used in place of the aforementioned timber, the NFPA text states that they shall have "fire resistance ratings of not less than one hour."

The accompanying photographs collected from various members of the American Institute of Timber Construction, illustrate some current types of heavy timber construction. From the data at hand, the aforementioned minimum timber size requirements are met or exceeded in all the structures shown. Today, clear spans in engineered timber construction run up to 250 feet in trusses, nearly 250 feet in glued laminated arches, and in excess of 100 feet in beams. Wood roof planking as thick as 4 inches and glued laminated timber cross sections as large as 26 inches by 108 inches are used.

Criteria For Fire Safety

In referring to the fire resistance and safety to life and property afforded by buildings of heavy timber construction, there is no intention of implying

that wood or timber structures will not burn under certain conditions.

In the minds of some, the term *noncombustible*, which merely means not combustible, has somehow come to be regarded as a synonym for fire safety. For some, the General Motors fire at Livonia did much to dispel this myth. The Factory Insurance Association stated (*The Spectator*, October 1953):

> "Therefore, before 3:40 p.m. on August 12, nobody even suspected that a fire like this could happen. The FIA considered the Livonia plant a low-rated risk. It was a non-combustible building with non-combustible machinery using non-combustible materials, and the end product was non-combustible."

In the $30,000,000 Livonia fire, or the destruction of the Pennsylvania Railroad Station in Philadelphia, much of the damage was due to structural collapse. Many other fires can be cited where little combustible material was involved but where the damage was great. Under some conditions therefore, the pounds of combustibles present in a structure may not be as important as such factors as the rate of burning, the effect of fire upon supporting structural elements and the facilities available for fire suppression. Though adding to the total of combustible material in a structure, heavy timber building elements are outstanding in providing the two factors of slow burning and resistance to failure; this second factor reduces the fear of building collapse always in the minds of fire fighters.

Double hammer-beam, ornamental type timber roof framing with glued members in Our Lady of Good Council Church, Newark, N. J.

How well a structure performs in a fire, rather than whether the materials of which it is composed burn, is the important criterion where effective automatic fire protection is not provided. Heavy timber construction contains more combustible material than light timber construction, but it performs better in a fire. It also performs better than certain assemblies of noncombustible building elements under similar fire conditions.

Other forms of damage from fire and fire fighting can produce worthlessness as costly as complete incineration. Metal warped by heat is seldom reusable; granite, marble and other stones, injured by heat, can seldom be matched; glass cracks or runs under heat; heat and hose streams spall concrete; and in fact it can be said that there is no building material that fire does not damage.

Fire loss records are collected in such a way that statistics on fire losses to buildings of heavy timber construction are not often segregated from losses on other forms of combustible construction and, therefore, detailed statistical comparisons are not possible. However, Colonel C. G. Richmond, former Chief of the Fire Protection Branch, War Department, Washington, D. C., reported, before the International Association of Fire Chiefs in 1944, on an analysis of 7,464 fires during 1939 – 1942 in sprinklered industrial buildings having masonry walls as follows:

> "If but five of these fires are eliminated from the analysis because of special conditions and the remain-

Sixty ft. sawn timber trusses in central bay, glued laminated lumber craneway trusses supporting 50 ton bridge crane, and glued laminated columns in factory building of Industrial Assets Co., San Jose, California.

ing 7,459 fires are analyzed, the average loss respectively in reinforced concrete, standard mill and brick joisted construction amounted to $348, $330, and $339. These figures give strong backing to the commonly made claim that automatic sprinkler protection properly installed and maintained over combustible occupancy reduces to a common level the probable extent of loss by fire in industrial buildings having masonry walls whether or not the interior construction is combustible or noncombustible."

Fire Resistance of Timber

Where the ratio of exposed surface to total volume is small, this slow conduction of heat allows extensive burning of the surface for a considerable period of time without dangerous depletion of strength. This is an outstanding factor when compared to some other building materials.

In heavy timber sizes, wood is hard to ignite. There must first be sufficient heat to drive out the moisture and to vaporize the gums and some parts of the fiber; these vapors will burn. There is then left the charcoal, which, being largely carbon, cannot be vaporized at normal fire temperatures. Sufficient heat will set up oxidation of this charcoal, but this oxidation is extremely slow, especially in heavy timber, in which the ratio of surface to mass is low. This has been proven by both experience and laboratory tests.

Hot locomotive coals and signal flares have been dropping on wood railway bridges and ties for many years — seldom with any significant fires. Mr. H. J. McKenzie, Chief Engineer of the Texas & New Orleans Railroad Com-

pany, speaking on wood bridges, stated (Annual Meeting of the American Wood-Preservers' Association, April 1950):

". . . last year we had 750 feet of packed chord bridge on fire, starting about 3:30 in the afternoon and burning for six hours. It was in an isolated spot and no fire fighting equipment was available. Fifteen section men with buckets were called out. They put out the fire, and we passed trains over the bridge two hours afterwards. We replaced about fifteen or twenty ties and a few lengths of rail that had become kinked. Incidentally, this bridge was about twelve feet high and most of the fire fighting had to be done from the ground. So you can see it is actually a slow burning bridge.

"Speaking of the fire hazard and how much chance you are taking per year with fire losses; I would say that our trestles are worth or rather cost about $20,000,000. Over the years we have spent annually around $5,000 replacing bridges that have burned. I would say that is a very small amount compared to the cost of the bridges and the trestling we maintain."

The mere fact that wood is combustible does not necessarily mean that it will spread fire.

The illustration on this page shows a cross section of a 9 inch by 27⅝ inch glued laminated beam which has been subjected to fire for one hour with temperatures ranging from 500° F. to 1600° F. and averaging 1270° F. It will be noted that the burning is quite uniform and the glue lines have little, if any, effect on the fire resistance of the timber.

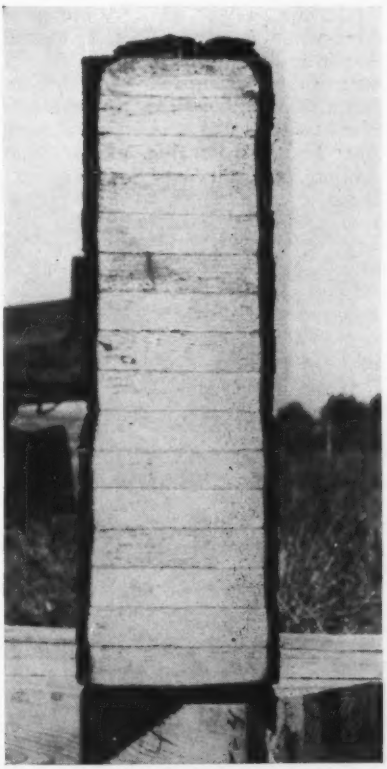
As the U. S. Forest Products Laboratory (*Wood Handbook*) states:

"The fire resistance of glued laminated structural members, such as arches, beams and columns, is approximately equal to the fire resistance of solid members of similar sizes."

Fire Retardant Impregnations

Fire retardent impregnated timber may ignite and burn, but the fire goes out as soon as the exterior source of fuel is removed, i.e., fire retardant treated lumber inhibits spread of fire.

Fires in the Navy Lighter-than-Air blimp hangars of wood construction, which are approximately 300 feet wide, 1,000 feet long, and 180 feet high with no partitions, give an indication of the



Cross section of glued laminated beam after being subjected to an average temperature of 1270° F. for one hour. The glue lines have little, if any, effect on fire resistance.

effectiveness of fire retardant impregnation of heavy timber members.

At Brunswick, Georgia, a blimp containing 450 gallons of aviation gasoline was burned in the hangar during refueling operations. The flames reached the fire retardant treated wood sheathing and framing for a substantial period of time and destroyed electrical conduit but did not damage, except for blackening or slight charring, the impregnated wood sheathing and framing.

At Richmond, Florida, following collapse from hurricane forces exceeding 2½ times those for which the building was designed, short circuits or metal sparks started fires in the contents of three wood hangars. It is estimated that in excess of 40,000 gallons of fuel were in the 14 blimps in operating condition, 366 airplanes, and 150 automobiles housed therein. Also, there were other highly flammable contents such as blimp bags, dope for blimp bags, etc. The intensity of the fire could be gauged from the fusion of glass, melting of copper parts and burning of various other metal parts of planes to ashes, and similar items. It is known the fire temperatures exceeded 2000° F. Due to a number of circumstances, the fire fighting was not a significant factor. The treated wood burned to ashes where flame was fed by the aviation gasoline, but the fire stopped in the wood members directly at the edge of the gasoline pools even though the framing members were badly shattered in falling nearly 200 feet and their untreated interior exposed to the fire.*

Economic Factors

It should be pointed out that the fire record of engineered timber construction conforming to modern code provisions is very good. Fires involving loss of life and severe damage in wood construction are mostly in older, non-conforming buildings with unprotected stairways, inadequate exits and similar unsafe features. Where modern knowledge pertaining to such items is applied, the record is good.

Both the fire resistance and salvage value of heavy timber construction is high — an item of considerable importance when paying the bill for repairing or replacing a structure. Even though the roof may have to be replaced after a severe fire, often the masonry walls can be saved because wood retains its strength until burned, has a relatively low linear thermal expansion coefficient, and is a very poor thermal conductor. Hence it does not tend to buckle with heat and displace the wall laterally, thereby causing collapse of the walls. Many heavy timber structures having severe fires retained adequate strength to be continued in service.

Summary

1. Technical advances, together with combined beauty, strength and economy, have greatly expanded the usefulness of heavy timber construction, and engineered timber construction with heavy sections is widely applied in buildings used for practically all purposes.

2. Glued laminated members have approximately the same fire resistive characteristics as sawn members of similar size.

3. Heavy timber construction permits egress of occupants without danger of sudden collapse of structure.

4. It permits fire fighters to ventilate and enter the building to fight the fire, and thereby reduces damage to contents and structure.

5. Having very low heat conductivity, it insulates adjacent areas of structure and contents from temperatures which cause ignition until actually reached by the fire.

6. Even with large quantities of highly combustible contents, it affords great fire resistance and strength permitting sprinklers to function and affording an opportunity to attack the fire in spite of delay in discovery.

*See NFPA Quarterly, October, 1945, page 89.

7. With heavy timber construction, there is a tendency in a fire to support rather than to displace masonry walls laterally and cause their collapse.

8. The salvage value is high, often permitting all or part of the structure to remain in service after severe fires.

9. Treated wood will burn when outside source of fuel provides a hot enough fire, but adequate fire retardant impregnation of heavy timber members is effective in stopping fires where and when the outside source of fuel, i.e., other than treated wood, is removed.

10. It takes quite a substantial fire to start heavy timbers burning and, even when a fire is intense enough to do so, ordinarily the fire in heavy timber will go out by itself when the source of outside fuel is consumed or removed. Any spread of fire while burning is very slow and, normally, in heavy timber construction, fire retardant impregnation of the members is not needed. It is a plus factor.

11. The fire record of engineered timber construction is good in properly designed structures conforming to exit, stairway, and similar requirements of modern codes. Severe building code restrictions and substantial insurance penalties on timber construction, compared with other constructions, can cause economic losses far greater than all fire losses.

12. Finally, the timber industry believes more recognition in building codes and insurance rates of the excellent fire resistance and fire safety qualities of heavy timber construction in relation to constructions using noncombustible materials is fully justified and would be in the public interest.

The University of Montana Field House which has a seating capacity of 6,500 people. The building has a 201 ft. 6 in. clear span using glued laminated lumber arches which are 11 ft. by 45½ in. in cross section, spaced 20 ft. apart with heavy wood purlins and a plank roof deck.

Roof Venting for Fire Safety

By E. J. Sestak

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During the past 35 years our major manufacturing plants have passed through three basic building design changes, each having its particular effect upon fire protection and potential fire losses. During and preceding the 1st World War the multi-storied structure of heavy wood timber or reinforced concrete design was commonly employed. This structure was usually long and narrow, with subdivisions and vertical cutoffs. This was followed by the one-story structure with roof of reinforced concrete, pre-cast, monolithic, or semi-mill type that usually had a monitor or sawtooth roof with numerous glass side lights, the latter for entry of light and ventilation.

With the further development and expansion of assembly line production methods has come the large steel deck flat roof single area factory building, void of fire walls, with some of the black-out type. For such design it was reasoned that since artificial illumination and mechanical air supply had to be employed to provide for concentrated high speed operations, there apparently was no need for the glazed and vented roof monitor.

In evaluating the relative merits of the various designs noted, we must not overlook the fact that the monitor structure with ordinary glass side lights afforded a channel for heat and smoke relief and thus permitted the fire fighter to enter the building and see and reach the seat of the fire.

This paper was presented at the Fall Conference of the National Fire Protection Association, Hotel Statler, St. Louis, November 27, 1956.

Catastrophe fires in recent years in large flat roof structures without adequate smoke and heat relief have demonstrated that the absence of adequate venting features are a major handicap to the fire fighter, with disastrous results. We have learned that the low flat roof structure of light noncombustible design, minus automatic sprinkler protection and minus venting, with even a limited amount of combustibles, presents a very vulnerable unit from a fire control and loss standpoint. Possibly following close behind in unfavorable fire record are the spot sprinklered structures, of like low unvented flat roof design where combustibles invariably find their way into the unsprinklered areas.

In fully sprinklered properties the provision of effective heat and smoke relief facilities should be looked upon as constituting the important second line of defense. An exception, however, would be a major special hazard department, such as painting, oil quenching, etc., where sprinkler protection plus good venting is vital and necessary.

Roof Vents Not New

The use of automatic vents is not new. Our city ordinances have for a long time required venting for theater stages.

However, very few municipal building codes *properly prescribe* adequate smoke and heat venting for manufacturing and warehousing buildings. While municipal codes devote considerable space to egress of the occupants, which is as it should be, such egress facilities

may not always prove to be the most effective for entry of the fire fighters, to put out the fire quickly in the area of greatest hazard and thus save the lives of the people who are trying to vacate the building.

While the installation of an effective sprinkler system does, to a large measure, lessen the physical shortcomings noted, nevertheless, where lives and important facilities are at stake, venting and access become very important, particularly if a sprinkler system may be out of service or impaired, or where the fire loading has been increased to the point that the sprinklers could be overtaxed or incapable of checking fire spread. In this connection it should be borne in mind that automatic sprinkler systems originally designed for limited water densities to serve a low hazard occupancy may now have to cope with manufacturing or warehousing hazards of greater potency.

This is particularly true where high piling of combustibles has been introduced. No doubt today there are plants where the sprinkler system designed on the basis of low pile heights and normal hazards could not control a fire, due to occupancy changes. While the word metal working, for example, normally denotes low hazards, be sure to study and evaluate all occupancy features before coming to that conclusion for the entire property.

These features are brought up under this subject heading of access and ventilation, as we may at times be expecting too much of the sprinkler system and develop a sense of false security and a feeling that certain essential basic features, such as venting, can be ignored or compromised, especially if hazards of considerable magnitude have been introduced.

Value of Monitors

As noted above, we have found that the ordinary glazed roof monitor affords a reasonably good channel through which heat and smoke can be dissipated. The roof monitor relieving the smoke and heat would permit entry of the fire fighters and close range water application for quick extinguishment. In addition, the numerous roof openings can also permit the fire fighters to approach the fire from the roof, if they deem such approach safe and advisable.

Perhaps the most vulnerable building today is the low flat unvented structure which has a combustible vapor seal, such as a bitumastic mopping and tarpaper between the steel decking and the roof insulation wherein the heat released by the burning contents is further amplified by the fuel from the dripping and burning tar at the vaporseal. An unsprinklered, poorly vented structure of this character, with even a low amount of fuel loading, is a likely candidate for complete fire destruction. Where such a structure is spot sprinklered and combustible contents find their way beyond the sprinklered areas, which happens in many cases, then such an extension of combustibles into the unsprinklered area can quickly nullify the action of the spot sprinklers and the fire could conceivably spread throughout the building. Being a low unvented structure, the fire department will experience considerable difficulty in reaching the seat of the fire and consequently, cannot be of too much help toward saving the plant.

Amount of Venting Needed

The amount of venting needed for a structure is principally dependent upon the fire loading, character of the stock and rate of burning. After observing the fire behavior in structures of moderate fire loading, it appears that roof venting ratios in the category of about one square foot of venting surface for each 40 sq. ft. of floor area would be classed as very good. For special hazard departments, such as quenching, and painting, venting ratios of 1 to 20 would be very desirable. For operations of low fire loading, venting ratios up to 1 to 150 could give a good account of themselves. These vents employed in

conjunction with either fire barriers or deep curtain boards of good design and distribution represent the proper combination for quick smoke relief and for localizing the fire.

Investigations have shown that there are so many variables which apply to the burning of combustibles that it is almost impossible to derive by mathematical means any precise requirements. The burning of flammable liquids is perhaps not subject to as many variables as solid combustibles. The burning rate of kerosene or quench oil is considered to be such as to release 30,000 Btu per minute per square foot of liquid surface. This would appear to mean that for such materials roof venting should be provided on the basis of venting hot gases resulting from the release of heat energy at that rate. If severe damage to exposed steel members is to be avoided, the temperature of the vented gas should not exceed 1,000°F. In excess of 1,000°F., the ultimate strength of steel falls below the usual design strength.

Test Data Inadequate

Unfortunately, test data under varying fire loads and rate of burning is rather limited on this subject. Generally, however, the engineer tries to approach the problem by first assembling known simple facts and formulae and then endeavors to prove their usefulness through test.

Thus, as a starting point a number of simple formulae can be utilized to determine the Btu's released from an anticipated fire and from this an attempt made to approximate the venting areas needed.

For example, the quantity of hot gases vented by natural means is expressed by a formula which can be obtained from any good engineering handbook:

$$Q = 9.4A\sqrt{H(T - T_1)}$$

Where Q = gas vented in cubic feet per minute
A = area of vent in square feet
H = height of gas column in feet
T = average gas temperature in vent, degrees Fahr.
T_1 = outside air temperature, degrees Fahr.

In addition, the quantity of heat required to raise the temperature of any gas from one temperature to a higher temperature is given by the formula:

Btu = Q × Specific Heat × Temperature Differential

Where Q is the quantity of gas heated in cubic feet per minute

I will not take up your time attempting to explain this formula which can be also obtained from any good engineering handbook. Assuming a certain Btu per minute released (this will require the use of first class guess meter), the above formulae can be employed to determine the venting area needed. The results obtained would, of course, have to be tempered in the light of other physical features such as size of segregated or curtain boarded area, depth of curtain boards, height of building, cross drafts, efficiency of vents, degree of fire spread, etc. Deep curtain boards surrounding the fire source play an important part in the efficiency of heat release where utilized in conjunction with an effective venting system. The most effective curtain board would be a deep one close to the fire source and not 200 to 300 ft. away.

It may be of interest to note that in large area buildings where conveyor facilities render a fire wall both impractical and ineffective, the combination deep curtain board barrier brought down within 10 ft. of the floor or lower, if possible, in a 25-ft.-high building, with good quick acting automatic vents on each side of this curtain has proven of value in checking fire spread under certain conditions.

So far, however, we have not found any good substitute for a standard blank parapeted fire wall. In general the well protected and arranged plant should incorporate certain basic design and protective features and when these are compromised we face trouble.

Today industry both big and small is placing too much plant under a common roof. As long as that practice continues major losses can be anticipated.

In the layout or rearrangement of departments housing hazardous operations or high density combustibles, location should not be dismissed too quickly just because segregation has been provided. An outside wall location is always desirable.

Hose Stream Protection

We must also remember that for a large area building when the point is reached where the fire fighter must take over, a 1⅛ in. hose stream at 100 lbs. nozzle pressure has only an effective range of about 100 ft. providing there are no obstructions in its path.

For the most desirable plant arrangement, manufacturing should be segregated from warehousing by standard fire walls or ample space separation. All important special hazards should be segregated by standard fire walls and provided with good drainage. Where combustibles are present automatic sprinklers are vital and all special hazard protection, such as carbon dioxide, should be backed up by automatic sprinklers with some exceptions. Venting for smoke and heat release should be provided and the degree necessary would depend primarily on fire loading and rate of burning and character of stock and type of structure. While automatic venting represents the ideal method of quickly releasing heat and smoke and is highly recommended for special hazard areas, it was pointed out that for the building proper where large areas are encountered the ordinary glass side lights of the roof monitor type give a good accounting of themselves and afford a simple channel for smoke and heat relief.

While there apparently is no one-step formula to apply, nevertheless this should stop us from preparing some simple guiding standards on venting for the use of the builders, property owners and architects. To eliminate guess work, such data to be of value should be substantiated by a series of appropriate tests.

Before I conclude, I would like to mention that some of our major industries have recognized these problems and have instituted corrective measures and have spent millions of dollars for automatic sprinklers, have adapted good venting for all new structures being built and have provided additional safeguards plus roof venting for both existing and planned special hazard departments. Much more is yet to be done and much more is visualized for the future. Others should take heed and follow.

Dust Explosions

Since 1900, reports of 1.083 dust explosions in the United States have been received by the Fire Record Department of the National Fire Protection Association. In these explosions 640 were killed, 1,709 were injured and property damage totalling $97,828,678 was suffered. Many additional explosions have undoubtedly occurred during this period which were not reported because of the absence of casualties and the smallness of the loss.*

To reduce the hazard of dust explosions the NFPA in 1922 established the Committee on Dust Explosion Hazards to develop recommendations for the prevention of dust explosions. Since then the Committee, with the cooperation of the industries affected, has prepared and kept up to date eighteen recommended Codes which indicate necessary measures to secure reasonable safety to life and property from dust explosions, each Code dealing with a particular dust-hazardous operation. Up-to-date revisions of these codes are published annually by the NFPA in National Fire Codes, Vol. II, and are also available as separate pamphlets.

Another NFPA committee, the Committee on Explosion Venting, has prepared in the form of a Guide for Explosion Venting material to supplement the explosion prevention recommendations. Recognizing the fact that despite sincere explosion prevention efforts, slip-ups do occur from time to time, the Committee on Explosion Venting has provided in the "Guide" useful information for the design and utilization of vents to limit pressures developed by explosions.

*A list of all dust explosions in the United States reported to the NFPA, including 34 occurring prior to 1900, has been prepared and will be appended to the record when reprinted in pamphlet form. The dusts involved, the cause of the explosion, number of deaths and injuries and dollar loss where known is given for each case.

If the recommendations of the Committees on Dust Explosion Hazards and Explosion Venting are applied intelligently the future record of dust explosions will be a substantial improvement from the experience of the past.

The following pages contain summaries of 75 of the more significant recent dust explosions. Extracts from recommended standards of the National Fire Protection Association that accompany most of these explosions indicate at least one "good practice," the violation of which appeared to have an important bearing on the cause of the explosion or the extent of damage. In many instances more than one weakness in the fire and explosion protection facilities contributed, and in others practically nothing could be determined about conditions at the time of the explosion because witnesses had been killed or all evidence had been destroyed.

The NFPA is indebted to members of the fire service, insurance inspection and rating bureaus, the Factory Mutual Engineering Division, Factory Insurance Association and the members of the NFPA Committee on Dust Explosion Hazards for the information which formed the basis of this study.

The dusts involved in the 75 explosions reported herein are:

Aluminum	1	Oat Bran	1
Bark	1	Paper	1
Coal	9	Peanut Hulls	1
Cork	1	Phthalic Anhydride	1
Corn	3	Plastic	5
Cotton	2	Rayon	1
Feed	3	Rubber	1
Ferromanganese	1	Soap	1
Flax	1	Soybean	4
Flour	6	Sponge Iron	1
Grain	14	Starch	2
Lacquer	1	Sugar Beet Pulp	1
Leather, Wood and Plastic	1	Sulfur	1
Lignin	1	Wood	5
Nicotinic Acid	1	Wood Flour	3

Aluminum Dust

POWER TOOL MFG., TOWSON, MD., AUG. 6, 1954; 2 KILLED

During plant shutdown for the summer vacation several equipment maintenance jobs were scheduled, including removal of aluminum dust from the screen section of a dust collector located in the yard. At the time of the explosion two employees were inside the collector using a homemade scraper consisting of a rusted aluminum-coated steel tube to remove dust from between the screens. Light was provided by two extension cords with open bulbs protected by metal guards.

A spark from the tool fell through the floor grating and into the hopper and cyclone unit below. Before the men could get out the explosion occurred that fatally injured both of them.

On hearing the explosion employees outside the collector notified the fire department and turned on open head sprinklers in the collector. These practically extinguished the fire although it was necessary for fire fighters to cut a hole in the top of the collector and extinguish a smoldering fire out of range of sprinklers.

Aluminum, Copper or Bronze Metal Tools, Including Shovels, and not iron or other spark-producing tools, should be used in any dust-making building except when that part of the plant is stopped, and then only after thorough removal of dust accumulation. This rule should also be followed in dismantling either inside or outside of the plant any discarded powder-producing equipment that may contain dust accumulations. **NFPA No. 651, Sec. 76.**

Bark Dust

LEATHER TANNERY, NEW ALBANY, IND., JULY 15, 1952; $441,500.

The unsprinklered 13,000 sq. ft. 1-story wood-framed bark house and the adjoining unsprinklered 19,500 sq. ft. 2-story brick, wood-joisted finishing building were destroyed by fire. A bark dust explosion in the early stages spread the fire beyond control.

The fire originated during the night in the vicinity of bark grinding machines and was attributed to a fault in the old and substandard wiring system for the grinding machine motors. The fire was not detected until an accumulation of bark dust exploded and alerted the watchman as he was walking toward the building. As he glanced toward the building, fire was seen in the vicinity of the grinding machines and almost immediately flames flashed throughout the dusty building. The explosion had been of sufficient intensity to blow grinding machine motors from

Coal dust explosion, Racine, Wisc., April 24, 1946. — Fire that was started in a pile of coal dust by sparks from a welding torch was followed by a dust explosion when the straight streams of a soda-acid extinguisher threw coal dust into suspension.

their mountings and had undoubtedly thrown burning bark about, explaining the rapid spread of fire after the explosion.

***All electric wiring and equipment shall conform to the National Electrical Code. In sections of the plant where dust accumulates or is present in suspension in the air all equipment and installations shall be in accordance with the requirements of Article 500 of the National Electrical Code (Hazardous Locations).* NFPA No. 63, Sec. "Electrical Requirements".**

Coal Dust

COAL ELEVATOR, NEW ALBANY, IND., SEPT. 23, 1942; $15,000.

While coal was being transferred by bucket from a barge to the coal bin, a dust explosion occurred. The ensuing fire destroyed the wooden bin. Investigators learned that there had been a fire in the coal while in the barge and concluded that the explosion occurred when hot coals were dropped into the dusty bin.

***In addition to the usual recommendations on fire prevention, attention is called to the hazard of spontaneous heating in many powdered products, particularly after grinding.* NFPA No. 63, Sec. "Fire Prevention".**

COAL STORAGE SHED, RACINE, WISC., APRIL 24, 1946; $50,000

Careless use of a welding torch was the cause of an explosion and fire that destroyed the wooden coal storage shed and damaged adjacent sheds. Coal dust in the vicinity of the conveyor tunnel was ignited by a welding torch and when the welder directed the stream of a soda-acid extinguisher at the blaze dust was thrown into suspension and exploded. Fire then flashed throughout the dusty building.

***Install first-aid protective equipment suitable for fires in combustible dusts such as small hose with adjustable spray nozzles, water pails, or approved extinguishers.* NFPA No. 63, Sec. "First Aid Protection".**

ACTIVATED CHARCOAL MFG., NEVILLE TWP., PA. AUG. 2, 1947; 6 KILLED, $220,000

Six men were killed and a congested group of buildings was destroyed by the flash fire that followed an explosion in a "whizzer" where the high volatile coal is partly broken before entering the pulverizing mill. From the pulverizer a screw conveyor carried pulverized coal to presses 50 ft. away in another building. The explosion was sufficient to shake the building and throw coal dust on structural members into suspension. Fire flashed through the screw conveyor to the Press Building where the flash of flames was so severe that six employees were fatally burned.

Hose streams were put in operation by employees from other sections of the plant and by volunteer firemen, but the sudden intense fire had involved the dusty interiors of the combustible buildings and there was no chance of saving them.

***As far as possible make equipment dust-tight and keep it so. This includes grinders, conveyors, elevators, collectors, or other equipment in which dusty material is produced, processed, or handled.* NFPA No. 63, from Sec. "Equipment".**

ELECTRIC GENERATING STATION, NEW YORK, N. Y. MAY 8, 1950; 2 KILLED

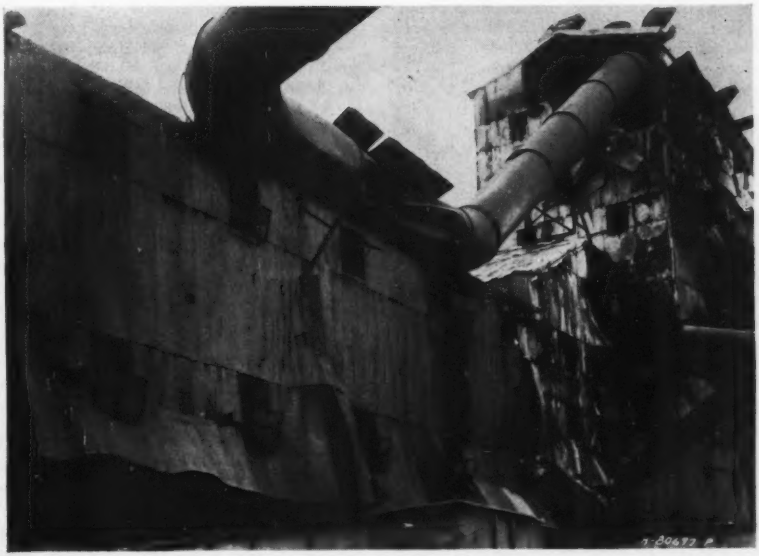
Following the routine blowing down of boiler water in a pulverized coal burning boiler, a bottom burner pipe was cleared of obstructions and work started on removing an elbow in the pipe. A cutting torch was used to remove nuts from the bolts of the flanged elbow, after which the torch was extinguished and the area under the burner box was wet down with a ¾-inch hose. When the elbow was swung out of position a quantity of coal dust fell out of the pipe and a mild explosion occurred. It is believed that hot particles of coal were in the pipe and fell out with and ignited the coal dust. Of the five employees burned by the flash two subsequently died.

***Extreme caution should be used in operations such as cleaning out plugged burners, burner piping, pulverized-coal bins, feeders or other parts of the system. Pulverized coal that may flood out or spill from such places can be ignited by a random spark or hot surfaces on which it falls, or may already be smouldering, and can produce intensely hot fire or explosion without warning.* NFPA No. 60A, from Sec. 521.**

BRIQUETTE PLANT, NEAR NORDEGG, ALTA., JUNE 14, 1950; $1,000,000

An overheated fan bearing was a possible cause of fire that originated in a wooden shed attached to a dutch oven in the 1-story brick and metalclad plant. When discovered by the watchman at 4:30 A.M. only smoke was visible. Using a hose that happened to be nearby, he directed it into the shed. Two small explosions occurred which threw clouds of dust into suspension and smoky, reddish flames flashed throughout the plant. Adjacent storage bins, coal dust bins and a tipple were also destroyed.

Use solid streams from hose or extinguisher with great caution where combustible dusts are involved. Dust may be thrown into suspension by their use with



Coal dust explosion, Lucernemines, Pa., Feb. 9, 1954. — A dust explosion in coal drying equipment killed three men and injured four others. Failure to locate the drier in a separate fire-resistive building or isolated room was one of the explosion protection weaknesses noted by investigators.

a consequent explosion. Spray or fog nozzles may be used with much less danger of disturbing dust deposits and spray nozzles should be available for use with all hose provided for fire protection where combustible dust is present. **NFPA No. 63, from Sec. "Hose Streams".**

Bituminous Coal Cleaning Plant, Lucernemines, Pa., Feb. 9, 1954; 3 killed, $500,000

Three men were killed, four were injured, coal drying equipment and the metalclad coal cleaning building were extensively damaged by an explosion of coal dust in the fine coal drying system. The explosion blew the housing from the vent fan and blew out, split or collapsed sections of ducts. Dust accumulations near the bag-type dust collectors and exhaust fans were thrown into suspension and ignited. The ensuing fire spread rapidly through much of the 180 ft. by 116 ft, by 97-foot-high building.

Investigators concluded that the explosion originated somewhere in the fine coal drying system (drying column, ducts, cyclone collector, vent fan). It was impossible to pinpoint the point of origin and cause because of the many possibilities present. Because the explosion occurred while the drying system was being put in operation after a 45-minute shutdown for changing of shifts, it is possible that a fire was burning somewhere in the system that had not been detected by either of the shifts.

Investigators called attention to the fact that the coal drier was not located in a separate fire-resistive building or isolated room as recommended in the NFPA Code for the Prevention of Dust Explosions in Coal Pneumatic Cleaning Plants.

Direct or semi-direct driers if not located in a separate building shall be separated from dust-making parts of the plant by means of substantial noncombustible partitions or walls constructed of materials having a fire resistance of not less than one hour in accordance with standard specifications for fire tests of materials for construction. **NFPA No. 653 Sec. 321.**

Chemical Plant, Barberton, Ohio, Sept. 14, 1955; $250,000

Following a plant shutdown due to a strike, employees were placing a pulverized coal-fired steam boiler in operation (385,000 pounds of steam per hour at 900 psi and 800°F.) when a coal dust explosion occurred that severely damaged the furnace.

Investigations indicated that improper operating procedure permitted the conditions to exist which caused the explosion. These conditions may be summarized briefly as follows. The day crew had worked on the furnace but had gone off duty before the lighting took place. Assuming that everything was in readiness for lighting and without checking the various control valves and equipment, the night crew proceeded with the lighting routine. No one noticed that an air control valve that should have been closed was open. Because of this condition excessive air flow was required to develop the necessary air pressure in the cyclone burner. Immediate steps were not taken to find the cause and correct it, and about an hour later, when someone discovered the open valve and closed it, the air flow though the cyclone burner thereby increased sufficiently to prevent continuous ignition of the cloud of pulverized coal. Thus, unburned coal dust discharged from the burner into the hot furnace where it exploded on reaching concentrations within the explosive range.

Failure of a forced-draft or induced-draft fan may set up a hazardous condition in the furnace, and the equipment shall be interlocked to stop promptly the flow of fuel to the burners if the air supply is appreciably reduced by the failure of a fan. **NFPA No. 60A, Sec. 431.**

FURNITURE FACTORY, GARDNER, MASS., DEC. 9, 1955; $1,000

Explosive blow-back in a pulverized coal fueled boiler in a detached fire-resistive power house did considerable damage to the boiler. The boiler was alternately fed wood waste or pulverized coal depending on the availability of the waste. Noticing the lack of waste for fuel the operator switched to pulverized coal but a temporary block in the feed line to the pulverizer allowed the coal to build up in the line. When the block finally cleared and discharged into the boiler, the explosion resulted which dislodged some of the boiler lagging and calking of the boiler seams.

Many types of units, arranged for burning pulverized coal, may also be equipped to burn other fuels, such as oil or gas, for alternate or simultaneous firing with pulverized coal in the same furnace.

Burners for such fuels shall be provided with suitable means for controlling the supply and proportioning of fuel and combustion air. **NFPA No. 60A, from Secs. 471 and 473.**

ELECTRIC GENERATING STATION, NEW YORK, N. Y., JAN. 21, 1956

An explosion in a pulverized-coal cyclone attached to a grinding mill ruptured the exhaust fan housing around the periphery, blew the hinged head from the roof terminus of the explosion venting pipe (the head landed on the center island of the East River Drive), broke pipe connections and blew a large number of wired glass window sashes from their frames.

Because of indications of hot spots in raw coal above the chute feeding the grinding mill two employees had entered the bunker to work the hot coal down into the mill. They found the coal hot enough to justify shutting down the mill and this was being done when the explosion occurred.

It appears probable that the dust explosion occurred in the cyclone when hot particles entered it from the grinding mill.

In case a fire occurs in a pulverized-fuel bin, the bin should be sealed against air infiltration and the pulverized fuel fed out and burned if possible. Steam and/or carbon dioxide should be admitted to the pulverized-fuel bin through connections provided in each pulverized-fuel bin. Such connections shall be at least 1-in. pipe. **NFPA No. 60A, Sec. 543.**

Cork Dust

CORK PROCESSING, BEAVER FALLS, PA., OCT. 3, 1932; $500.

A spark from foreign material passing through a fan was the probable cause of a cork dust explosion in the collector on the roof. Due to the fact that the explosion vent on the collector had rusted tight the sides of the collector were bulged and in general the damage was greater than would normally have been the case.

Ice crystals may form between explosion venting sash and the frame during cold weather due to high humidity in the area producing a cementing action on the vent and thereby allowing greater pressures to be built up before the vent will open. A coating of grease on the adjacent surfaces may prevent the bridging of the ice crystals between the members of the vent.

Corrosion and paint may also increase friction in opening this type of vent. Precautionary measures should be taken to prevent the moving and sliding parts from being affected. **NFPA No. 68, from Sec. "Important Basic Recommendations."**

Corn Dust

FEED MILL, WAYNESBORO, GA., MAY 25, 1955; 3 KILLED, $265,000

Three employees were killed, thirteen were injured and extensive property damage was caused by a violent dust explosion which originated in the unvented basement of a 2-story reinforced concrete corn shelling section adjoining the reinforced concrete main elevator building.

Of the several substandard fire and explosion prevention features two and possibly three were believed responsible for the explosion and the resulting deaths, injuries and property damage. First, there were no explosion venting areas by means of which explosion pressures could be released before causing extensive damage to the reinforced concrete building. Second, there were no dust collecting systems and finally, much of the electrical equipment was not approved for atmospheres containing grain dust.

Minutes before the explosion occurred an employee had entered the basement of the corn shelling section to sweep and clean this area. The death of this man prevents any definite conclusions as to what happened. It is felt, however, that the sweeping operation may have thrown dust which was ignited by electrical equipment into suspension. Switches and circuit breakers in the basement were not suitable for atmospheres containing grain dusts.

The explosion destroyed the corn shelling section, the adjoining 1-story reinforced concrete bag storage and shuck baling sections, and several

Corn dust explosion, Memphis, Tenn., Jan. 27, 1955. — Foreign material that entered a grinding mill with corn was the probable cause of this dust explosion. No means was provided for removing foreign material from the grain before it entered the grinder.

communicating 1-story all-metal and masonry, wood-joisted storage and receiving areas. That part of the 7- to 10-story main building which adjoined the corn shelling section contained elevators, driers and processing equipment. Equipment on all floors was destroyed or badly damaged. Fires broke out on all floors (as they did also in the rubble of the destroyed 1- and 2-story sections) but for the most part the flames died down in a few minutes, after the dust had been consumed.

Fire involving dust and the conveyor belt in the conveyor gallery above the grain bin section of the main building was extinguished with hand extinguishers. Hose streams were not used, as it was feared that the 200,000 bushels of grain in bins would become water soaked and possibly cause building collapse.

***Locating hazardous operations or equipment in basements or areas partially below grade should be avoided due to the difficulty of providing adequate venting.* NFPA No. 68, from Sec. "Important Basic Recommendations".**

FEED MILL, MEMPHIS, TENN., JAN. 27, 1955; $625,000

A dust explosion blew out a large section of the reinforced concrete walls of the 85-ft.-high elevator, blew small holes in the workhouse floor (bin top), removed inspection covers and lifted the concrete roof of a raised section of the elevator several feet. The explosion is believed to have originated in a quarter bin into which cracked corn was being dumped after passing through a cracker on the first floor.

No employees were above the first floor when the explosion occurred. Of the 50 men on the first floor nine were injured. The clothing of one was ignited by flames that flashed down the shaft bin to the track platform. Twenty-two sprinklers on the first and work floors held the ensuing fire in these areas in check. Hose streams were used for 24 hours to put out the several small fires in the grain bins.

No means were provided for removing foreign material from grain before it entered grinding mills, lending credence to the belief that grain ignited by a friction spark may have been carried into the quarter bin where it ignited a dust cloud.

***Approved permanent magnets or approved self-cleaning electro-magnetic or pneumatic separators should be installed in an approved manner ahead of all shellers, crackers, crushers and grinding machinery.* NFPA No. 61C, Sec. 3091.**

FEED MILL, VALPARAISO, IND., JUNE 15, 1956; $10,000

An employee was badly burned and the cupola of the metalclad elevator at this mill was seriously damaged in an explosion that occurred while 1954 crop corn was being loaded into cars. The loading-out spout in which the explosion originated extended from a turn-head in the elevator cupola to the outside and then passed downward through the roof of the mill room to a blower.

A welder was on the roof making repairs to the loading-out spout with instructions to stop work whenever he heard corn being loaded. The inadequacy of this precaution is evident from the explosion that occurred on one of the occasions when an employee pushed the starter button for the elevator leg motor. Action of the cups apparently caused a cloud of dust to pass down the spout before the welder had time to shut off his torch.

The explosion extended up the spout to the elevator head where a second more violent explosion occurred in the all-steel leg. Ten feet of the up leg was split, one wall of the cupola was blown out and two walls were bulged by the latter explosion.

***All machinery and dust producing operations from which dust may reach the area or within range of welding sparks must be shut down prior to the start of the welding or cutting job and remain inoperative until the job has been completed and final inspection is made.* NFPA No. 61C, Sec. 8143.**

Cotton Dust or Lint

COTTON FLOCK MFG., NEWARK, N. J., MAR. 9, 1938; $70,000

An explosion originated in a flock grinder through which a mixture of white shirt cuttings and cotton waste was being run. A piece of tramp metal was the cause. Apparently the first explosion threw a heavy accumulation of dust and lint into suspension, which exploded with considerable violence. Reports are not clear on this point although they do state that an explosion occurred of sufficient violence to break a branch line of sprinklers in the fourth story, two stories above the location of the flock grinder. Sprinklers other than on the fourth story performed satisfactorily and held the fire on lower floors in check while fire department hose streams were used to extinguish fire in the fourth story.

***Pneumatic or magnetic separators for preventing metal objects from entering grinding equipment are important.* NFPA No. 63, from Sec. "Grinders".**

Feed dust explosion, Lewiston, Idaho, Sept. 12, 1951. — Had the watchman patrolled inside the mill instead of just outside he probably would have discovered the conditions responsible for the dust explosion at this feed mill.

ROOFING PAPER MFG., SKANEATELES FALLS, N. Y., SEPT. 19, 1938; $500.

A rifle cartridge in rags being cut on a hooded rag cutter exploded causing a fire that flashed through a metal cyclone collector and on to a cloth screen dust collector in the top story. A mild explosion occurred at the cloth collector which bulged the metal top before venting itself through the cyclone into the top story. Heavy clouds of smoke coming from the cyclone made fire fighting difficult for employees who used two 1½-inch hose streams for an hour before finally extinguishing the fire in the cyclone. Operation of two sprinklers in the collector saved most of the cloth screens.

Explosion relief vents should be provided on all duct systems used for conveying materials which form an explosive mixture with air.

***Explosion relief vents for ducts should lead by the most direct practical route to the outside of the building and should not deviate more than 22½° from the direction of the duct from which they lead.* NFPA No. 91, from Secs. 451 and 452.**

COTTON MILL, BONDSVILLE, MASS., MARCH 9, 1939; $1,000

Fire that originated in the duct system that exhausts dust from nappers in the top story of a 3-story mill was probably caused by a spark from foreign material in the duct. Fire spread to the collector on the roof and through a 48-ft.-long metal duct to the dust tower on the roof of an adjacent building. Here an explosion occurred that blew out about 100 square feet of brick wall. Six 12-in. by 36-in. explosion vents (total area 18 sq. ft.) had been installed in the 900 sq. ft. tower. The height of the tower was not given but if it was 10 ft. high (volume 9,000 sq. ft.) the minimum venting area for the enclosures as recommended by the Explosion Venting Guide would be 180 sq. ft.

Based upon small scale tests and field experience it is recommended that vents for the protection of buildings and equipment be installed on the following basis:

***"Fairly large enclosures" of 1,000 to 25,000 cubic feet such as bins, silos, rooms, storage tanks, etc.: 1 square foot for each 30 to 50 cubic feet. (Here, one must attempt to predict the point of origin of the explosion with respect to the vent and the actual volume which may be involved.)* NFPA No. 68, from Sec. "Vent Ratio Recommendations".**

COTTON MILL, WARE SHOALS, S. C., MAY 24, 1952; $1,000

An arc from a bare motor lead was the probable cause of fire that broke out at a napper machine. Although the fire at the machine was extinguished by two sprinklers and extinguishers used by the plant fire brigade, fire had been blown through ducts to the outdoor dust house where a dust explosion occurred. A wall of the dust house

blew out and several windows in the exposed wall of the mill were broken. Fire in the dust house was extinguished by eight sprinklers and one large hose stream.

***Separating or collecting equipment should be located at a safe distance from combustible construction or unprotected openings into buildings.* NFPA No. 91, from Sec. 443.**

Feed Dust

(See also Grain Dust)

FEED MILL, LEWISTON, IDAHO, SEPT. 12, 1951; $252,000

At 1:35 A.M. a passing motorist noticed that the 1- and 5-story wooden mill was in flames and drove to fire headquarters to give the alarm. A telephoned alarm was received at the same time from the watchman who patrolled outside the 300-ft.-long building only. The watchman stated that he heard a light explosion followed by one of greater violence after which fire spread rapidly throughout the building. He seemed to think that the first explosion occurred in the headhouse.

The local fire chief had never been successful in convincing the mill owners of the necessity of cleaning the mill each day, including removal of dust from ledges.

***All combustible buildings should be patrolled by watchmen reporting to approved time recording apparatus. Rounds, apparatus, etc., shall conform to requirements of the authority having jurisdiction. The employment of watchmen in noncombustible elevators, tanks, or driers, is desirable for reasons outside the scope of these rules, but it is not considered especially necessary in relation to fire and explosion hazard, unless combustible materials are present in quantity sufficient to produce a serious fire. See Article 704 for recommendations as to lights for use of watchmen. For further information on this subject see the Watchman, Suggestions for Guidance in His Selection, Instruction and Duties.* NFPA No. 61C, Sec. 9021.**

FEED MILL, CEDAR RAPIDS, IOWA, MAY 22, 1952; $900.

Two explosions occurred in ducts on the exhaust side of a cyclone collector which separated feed after it was passed through a flash drier. Under normal operating conditions the mixture of combustion gases and air is 1000°F. on entering the drier and is 300°F. on leaving the collector. Apparently a feed stoppage occurred at the cage mill (where feed and the hot gas-air mixture are mixed before entering the drying column) which permitted the hot gas to pass through the drier without losing heat. Dust deposits on the exhaust side of the collector are believed to have been ignited by the hot gases.

***An automatic secondary or emergency control system of approved type shall also be provided to perform the following functions: (1) Shut off the burner in the event of excessive temperature in hot air duct or manifold discharging to drying section; (2) Cut off fuel supply in case of power or flame failure, or of partial or total interruption of air movement through hot air fan; (3) Shut down the feeder mechanism of drier to prevent further movement of grain from drier to any other building, stop the fans, and cut off the fuel supply to burner in the event of excessive temperature in the exhaust from drying section.* NFPA No. 61C, Sec. 4105.**

FEED MILL, OLEAN, N. Y., NOV. 10, 1953

This unsprinklered 5,000 sq. ft. 3-story wooden mill and three small adjoining buildings were destroyed by fire that spread rapidly through the dusty mill after a dust explosion occurred in an elevator leg. The ignition source was reportedly friction between a slipping belt and a pulley.

***All elevator legs should be equipped with an automatic mechanical or electrical, tamper-proof device to shut off driving power for leg, in case leg belt slows down, and an interlocking device should simultaneously shut off power on all contributory conveyors (either screw or belt) which feed leg.* NFPA No. 61C, Sec. 3031.**

Ferromanganese Dust

MINERAL GRINDING, EXTON, PA., APRIL 18, 1952; $1,200.

An explosion in a ball mill being used to convert 50 to 80 mesh high carbon ferromanganese to 200 mesh was followed by a more violent explosion in dust collecting and storage equipmen tinto which the mill discharged. The grinding mill in which the first explosion occurred was constructed of a steel shell and steel balls, and was unvented. Such a mill was satisfactory for grinding noncombustible minerals (materials normally handled at this plant), but because of the possibility of sparks being generated by the steel balls against the steel shell was not suitable for grinding combustible dusts. Ignition of a dust cloud in the mill by a friction spark was the probable cause of this explosion.

***Bronze or other nonsparking metal is recommended wherever practicable in the construction of grinding equipment.* NFPA No. 63, from Sec. "Grinders".**

Flax Dust

LINSEED OIL MILL, MINNEAPOLIS, MINN., Nov. 29, 1950; $375,000

Foreign material in flax being cleaned in a machine on the first floor was the probable cause of a dust explosion at 2:15 P.M. that blew out a 25-ft. section from each of two walls of the wood-framed, metalclad elevator. Sprinklers held the ensuing fire in check in sprinklered areas but water could not reach hidden fires in unsprinklered bins, cleaning machinery and grain handling equipment.

At 3:00 P.M. firemen apparently had fire under control and at 4:30 P.M. ordered sprinklers shut off. At 6:00 P.M. a violent explosion occurred on the upper floors of the 6-story building. Sprinklers were again turned on but due to broken piping were of no value on the fire that was now raging throughout the structure. At 11:45 A.M. Nov. 30 the building collapsed. Reports did not suggest the cause of the second explosion.

When it is impractical to locate hazardous operations or equipment outdoors, they should be located, where practicable, in a single-story building or on the top floor of a multi-story building, or in a lightly constructed penthouse and vented directly to the outside through ducts of adequate cross-sectional area. **NFPA No. 68, from Sec. "Important Basic Recommendations".**

Flour Dust

FLOUR MILL, NEWPORT, KY., FEB. 14, 1943; $57,500

Fire originated in a pile of flour near a flour sacking machine in the first story. When firemen arrived and directed a hose stream at the fire a muffled explosion occurred that spread flames to all stories of the unsprinklered 3-story brick, wood-joisted building.

Fire department or standpipe hose streams should be used with great care around an elevator or mill. Their careless and unnecessary use may cause dust explosions by throwing dust into suspension. One and one-half inch hose and combination fog and straight stream nozzles are recommended. **NFPA No. 61C, Sec. 9041.**

FLOUR MILL, NORTH KANSAS CITY, MO., FEB. 18, 1944; 4 KILLED, $1,500,000

Four men lost their lives and 20 were seriously injured when a terrific dust explosion wrecked portions of this 1- to 8-story fire-resistive mill and the adjoining and communicating fire-resistive grain storage tanks. Numerous sporadic fires broke out and due to a serious manpower shortage in the fire department and difficulty in reaching the seat of the fire in sacked flour, bran and empty bags in bales, the fires were not finally extinguished until six days later.

The explosion apparently originated in the basement or second story of the grain cleaning section. One wall of the first and second stories was blown out, the first and second floors were blasted to bits and two freight cars on a siding were overturned. The force of the blast extended up an elevator and stair shaft blowing out shaft walls and shattering windows. Extensive damage was also inflicted on detached groups of storage tanks which explosion pressures reached via conveyor tunnels and overhead galleries that connected the tanks with the cleaning section of the mill.

Two conditions at the mill were primarily responsible for this disastrous explosion: 1, excessive dust accumulation; and 2, absence of explosion vents. No positive ventilating equipment was provided for garners, scale hoppers, heads, boots or belts in the grain handling section. Fire department inspectors had reported heavy dust accumulations in the building on their routine inspections. Cyclone collectors on the roof that were connected to grinders and cleaners discharged to atmosphere, a 12-in.-deep layer of dust having accumulated on the roof.

All heads, boots and garners, shall be dust-tight and provided with adequate positive air aspiration or effective vents to outside.

As many sweepers shall be employed as are necessary to keep the building clean. **NFPA No. 61C, Secs. 5011 and 6013.**

Vents are generally required in buildings containing operations or departments where combustible dusts can accumulate, or where flammable gases, vapors or mists, including aerosols in fumigation, may be present in sufficient amounts to create explosive concentrations in air. **NFPA No. 68, from Sec. "Important Basic Recommendations".**

FLOUR MILL, GALT CITY, ONT., DEC. 9, 1946; $500

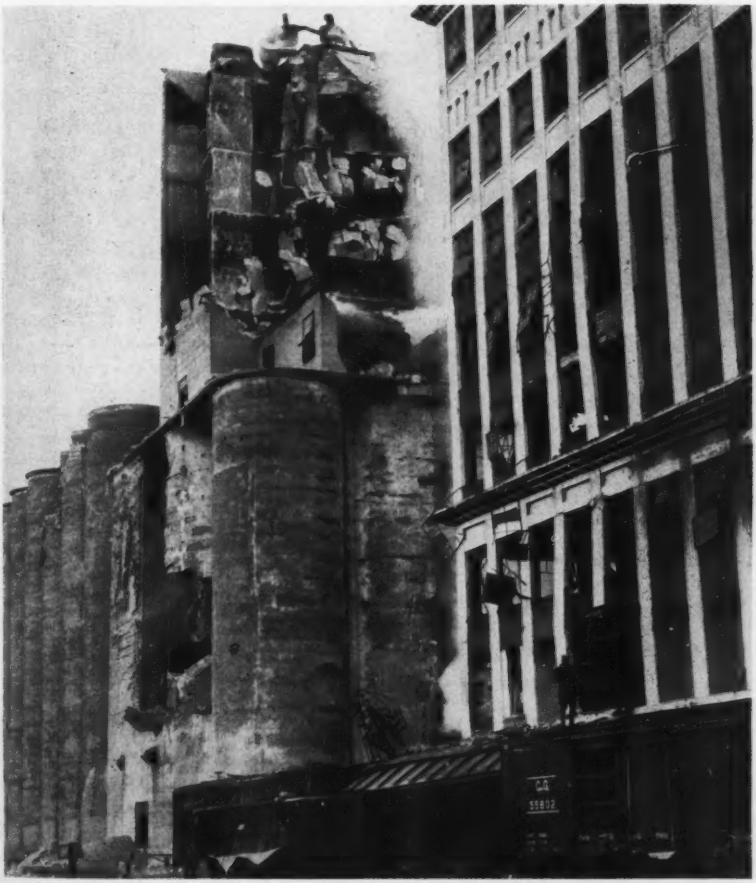
This explosion occurred in a flour bin 3 ft. in diameter, of wooden construction and which extended from the second to the fifth floors. The bin was almost empty. An employee had just opened a wooden inspection door at the fourth story level when the dust cloud exploded blowing the top off the bin and shattering all windows in the fifth story. Mechanical and electrical sparks were eliminated as possible ignition sources by investigators.

Flour dust explosion, Hutchinson, Kan., May 1, 1947. — Improper training of employees for fire emergencies was responsible for the disastrous explosion. Instead of calling the fire department on discovering a bait fire, employees attacked the blaze with solid stream extinguishers and pails of water, thereby stirring up dust that exploded.

FLOUR MILL, HUTCHINSON, KAN., MAY 1, 1947; $200,000

A 65-year-old, wooden flour mill, long recognized as a fire hazard, was destroyed by a fire which started from a choke in the elevator. Friction set the belt on fire as the elevator stuck. Employees shut down the mill and attempted extinguishment with solid streams, water-type extinguishers and with pails of water. Instead of accomplishing their purpose, they stirred up a great deal of dust which was ignited by the burning belt. Several small explosions were followed by a larger one which sent flames throughout the structure and nearly trapped employees. In the resulting confusion, no one thought to turn in an alarm for at least 20 minutes.

Firemen found the situation hopeless as far as the mill itself was concerned and concentrated on saving exposed properties, surrounding the burning building with 8 high pressure hose lines. Three of the lines were furnished from pumpers drafting from a nearby creek. An aerial ladder was placed in service as a water tower, using 2 lines. Seven houses were ignited from flying sparks but damage to these structures was light. The fire department report emphasizes the price



Flour dust explosion, North Kansas City, Mo., Feb. 18, 1944. — A heavy dust accumulation throughout the mill was one of two explosion protection weaknesses primarily responsible for this explosion that killed four men and injured 20 others. Another serious weakness was the lack of explosion venting facilities.

guishers and pails of water, thereby stirring up dust that exploded.

paid for the delayed alarm and states that if prompt notification had been received it could undoubtedly have conquered the fire by releasing water spray into the elevator leg to settle the dust, thereby preventing the explosions. Once this hazard was overcome, extinguishment of the belt fire would have been possible without serious contents or structural damage.

Install first-aid protective equipment suitable for fires in combustible dusts such as small hose with adjustable spray nozzles, water pails, or approved extinguishers.

Plant employees should be instructed and drilled in proper methods of handling fires in combustible dust and the local fire department should be advised of the hazards involved. **NFPA No. 63, from Sec. "Fire Extinguishing".**

BAKERY, KANKAKEE, ILL., JULY 15, 1948, $30,000

The dust collecting system, including duct work, was destroyed by an explosion that originated in one of the collectors. It was surmised that moist dust which had collected in the bins of the collecting system had probably ignited. Ignition of a dust cloud may have occurred when an accumulation of dust dropped into one of the collectors. Fires that broke out in the 3-story noncombustile building were extinguished or held in check by 18 sprinklers.

Ground all machinery capable of producing static sparks. Guard against spontaneous heating of dusts and powders. **NFPA No. 63, from Sec. "Sources of Ignition".**

FLOUR MILL, ST. BONIFACE, MAN., JUNE 11, 1953; 1 KILLED

An employee was killed by a dust explosion in a 6 ft. by 6 ft., 24-ft.-deep flour bin. The explosion occurred while the employee was bending over the bin manhole checking the flour level and banging an extension light with dust-tight globe against the inside of the bin to knock flour from the sides.

Avoid the use of ordinary extension or drop lights inside of bins. **NFPA No. 63, from Sec. "Bins and Hoppers."**

Grain Dust

See also Corn Dust, Feed Dust, Flour Dust, Soybean Dust.

TERMINAL GRAIN ELEVATOR, PORT ARTHUR, ONT. AUG. 7, 1945; 22 KILLED, $750,000

Breaking of an ordinary light bulb or ignition of dust on the bulb was the probable cause of the primary dust explosion in the basement of a large storage annex consisting principally of reinforced concrete storage tanks. Due to the absence of venting facilities the 18-in.-thick reinforced concrete basement wall was blown 35 feet from the building. Immediately explosions occurred throughout the 187-ft.-high reinforced concrete work house and the cupola house of the annex.

Brick panels of the workhouse walls, as well as concrete girders, were scattered for more than 300 feet. The only way to the ground from upper stories of the work house consisted of a shaft for the stairway and elevator, with unprotected openings at all floor levels. This shaft was completely demolished.

Among the substandard features of this elevator that contributed to the deaths, injuries (27) and property damage were: almost complete lack of dust control and dust removal equipment with consequent poor housekeeping conditions: open electric light bulbs merely protected by a wire guard and controlled by ordinary toggle switches; open-topped tanks in the annex; elevator heads not vented through the roof; unprotected openings in stair shaft, and grossly inadequate explosion venting area in walls.

All rooms and areas including basements, tunnels and galleries, and space around track hoppers shall be well ventilated by windows or otherwise to comply with minimum requirements of Section 1034.

Wherever the elevator design will permit, a minimum of one (1) square foot of explosion vent area for each eighty (80) cubic feet of air volume of working area on each floor should be provided, at least fifty per cent (50%) to be of a design which can be open under normal operating conditions. **NFPA No. 61B, Secs. 2021 and 1034.**

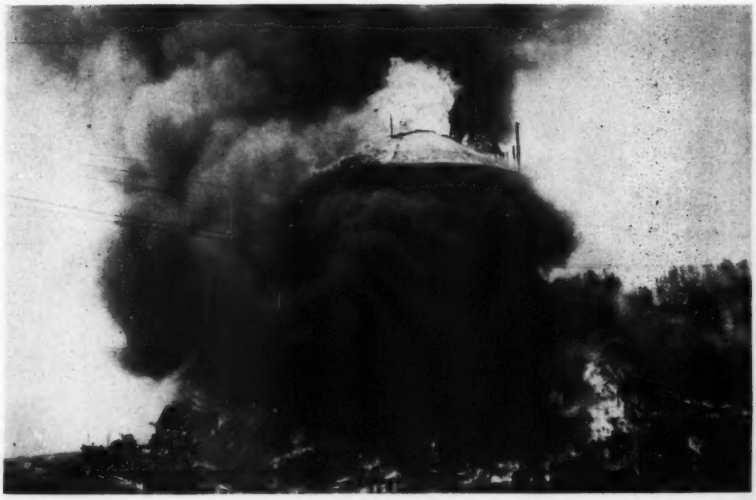
TERMINAL GRAIN ELEVATOR, MINNEAPOLIS, MINN. DEC. 25, 1945; $567,000

Six hours after the main elevator building had been closed for the holiday, the fire department received notification via the central-station-connected automatic fire detection system of fire in the distributing floor above the tops of the cribbed bins. Firefighters dragged hoses up through the 130-ft.-high elevator but were forced to withdraw almost at once because of intense heat. They had just cleared the building when two dust explosions raised the roof and spread fire throughout the old unsprinklered wood-framed, metalclad structure.

An approved system of automatic sprinklers is recommended for any combustible elevator, and, where feasible, for the protection of such parts of noncombustible elevators as contain combustibles, other than grain and belts, in quantity sufficient to produce a serious fire. **NFPA No. 61B, Sec. 9061.**

Grain dust explosion, Port Arthur, Ont., Aug. 7, 1945. — Twenty-two men were killed and 27 injured in a series of explosions that originated in the basement of the dusty building. An ordinary light bulb being used in a dust-hazardous area was the probable ignition source. A stair and elevator shaft with unprotected openings provided the only route to the ground for employees in upper stories. Destruction of the shaft necessitated removal of men by a bosun's chair.

Grain dust explosion, Moro, Ore., May 5, 1949.—The feed grinding operation at this country elevator was not segregated from the grain storage section as recommended in the Code for the Prevention of Dust Explosions in Country Grain Elevators. Fire that originated in an attached 1-story grinding room spread into the elevator where a dust explosion occurred.



TERMINAL GRAIN ELEVATOR, DECATUR, ILL. OCT., 2, 1946; 1 KILLED, $6,500

Choke-up of a bucket elevator resulted in friction between the belt and pulley. The resulting fire was not detected until the foreman noticed that part of the elevator housing was red hot. Plant firemen responded at once but almost immediately after their arrival the belt burned in two, fell within the housing and raised a dust cloud that exploded. The explosion extended throughout most of the building by means of four interconnected grain elevating bucket belt housings and through the dust collecting system.

Of the seven employees burned by the explosion one died three days later. Fires broke out in bins and in the dust collector on the roof but were

extinguished with fire department hose streams before getting out of control.

All elevator legs should be equipped with an automatic mechanical or electrical, tamper-proof device to shut off driving power for leg, in case leg belt slows down, and an interlocking device should simultaneously shut off power on all contributory conveyors (either screw or belt) which feed leg.

A distinctive alarm or signal should notify operator in case of shutdown. **NFPA No. 61B, Secs. 3031 and 3032.**

COUNTRY GRAIN ELEVATOR, MORO, OREGON, MAY 5, 1949; $329,000

Before going home for lunch employees closed and locked all exterior doors but did not close a fire door separating the circular 65,000 bushel grain elevator and the adjoining 1-story feed room. This oversight was responsible for destruction of the group of elevators and mill buildings since fire that broke out in the feed room during the lunch hour had entered the circular elevator before discovery by outsiders. Ten minutes after the fire was discovered a dust explosion occurred that spread the fire to adjoining storage and office sections.

Although total destruction prevented determination of the cause of the fire an automatic 3-hp open type air compressor motor in the feed room may have been responsible. It was learned that on previous occasions the motor had stuck when the automatic switch had cut in and it was also learned that there was a considerable accumulation of dust, oil and lint on and adjacent to the motor.

If feed grinding or milling operations are carried on they should be conducted in a separate building, or segregated section of the plant constructed and operated in accordance with the Code for the Prevention of Dust Explosions in Flour and Feed Mills. **NFPA No. 64, from Sec. 201.**

FEED MILL, SPARTANBURG, S. C., AUG. 20, 1949; $35,500

At 6:58 P.M., the watchman heard a "swooshing" noise in the grain warehouse and almost immediately thereafter heard an explosion. Investigators believe that the "swooshing" noise may have been caused by collapse of a wooden bin or escape of the contents through a break in the side of one of the bins that were filled to 94.3 per cent of capacity with corn, fish scraps, barley, oats, clover screenings and bran. Dust thrown into suspension by the movement of grain and ignited by a spark from broken electric wiring would account for the ensuing explosion.

The bins were severely damaged and two brick walls of the warehouse were blown outward by the explosion but fire damage in the warehouse was kept to a minimum by the operation of 25 sprinklers. However, fire in an enclosed unsprinklered belt conveyor between the grain warehouse and feed mill spread into the feed mill where moderate damage resulted before it was controlled by nine sprinklers.

Construct bins and hoppers of strong noncombustible materials such as sheetsteel, steel plate or reinforced concrete. All bins should be provided with dust-tight cover or deck with ventilating duct extending to outdoors. **NFPA No. 63, from Sec. "Bins and Hoppers".**

TERMINAL GRAIN ELEVATOR, PERRYTON, TEXAS, APRIL 24, 1950; 1 KILLED, $87,000

The explosions in the two adjoining and communicating elevators show what can happen in a fire-resistive elevator when provisions for dust control are not adequate to maintain a reasonably clean house. In this instance exhaust fans were provided in each elevator head but these were insufficient to control the dust hazard resulting from the constant turnings of wheat in storage.

On the morning of the explosion a bad choke occurred while grain was being turned which made it necessary for two employees to spend several hours in a covered pit below the level of the conveyor tunnel emptying the boot. At 2:00 P. M., as they were cleaning up the pit and shoveling grain back into the elevator boot a flash occurred followed by an explosion in the elevator stand and in the cupola of one of the elevators. Immediately thereafter, a second explosion occurred in the basement and elevator stand of the adjoining elevator. A third explosion occurred in the upper leg and cupola.

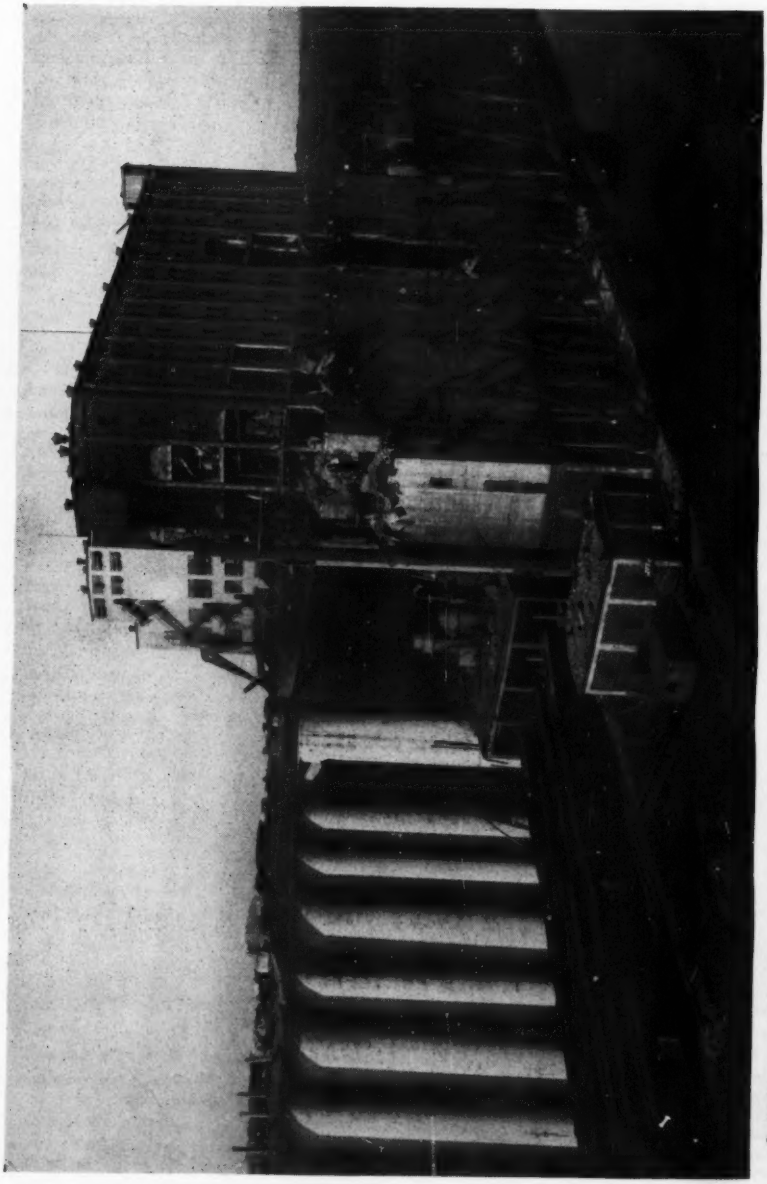
One of the two employees was killed and the other was severely burned. Both elevator stands were demolished and considerable damage was suffered by one of the cupolas, three walls of which were badly sheared.

All heads, boots and garners shall be dust-tight and provided with adequate positive air aspiration or effective vents to outside.

Boots should be above the floor rather than in pits and be provided with adequate clean-out doors. **NFPA No. 61B, Secs. 5011 and 3021.**

FEED MILL, FORT WORTH, TEXAS, FEB. 21, 1952; 1 KILLED, $200,000

An explosion in a hammer mill on the second floor killed one employee and seriously injured



Grain dust explosion, Port Arthur, Ont., Sept. 24, 1952. — Six men were killed and 14 were injured in an explosion that occurred while refuse screenings were being spouted into a ship. The primary explosion in a shipping bin was followed by secondary explosions that involved the large quantities of dust that had been allowed to accumulate in the building.

Grain dust explosion, Forth Worth, Texas, Feb. 21, 1952. — An explosion in a hammer mill in the first story was responsible for one death and the destruction shown here.

another. The explosion entered the reinforced concrete bin that extended from the third through the seventh stories of the adjoining 8-story elevator building and from which screenings were fed to the mill. The bin had just been emptied, the mill was running idle and was about to be shut down when the explosion occurred. Since bins were interconnected at the top and there were no bin vents to outdoors, damage in the top story and in the adjoining bins was severe.

Equipment and the sprinkler system in the eighth story of the elevator building were demolished, a large section of bin tops was wrecked and a section of bin wall in the third story was blown out. Fire that broke out in sacked feed in the eighth story was extinguished by two fire department hose streams. Sprinklers operated in the third story where the bin wall was blown out and also in the basement near the discharge spout from the hammer mill but no fire broke out at either location.

Cause of the explosion could not be determined but is presumed to have been a piece of metal that entered the hammer mill with the screenings. No magnetic separators were provided at the hammer mill.

Properly designed and located vents will relieve the pressure resulting from an explosion and prevent or reduce damage to buildings and equipment. The required area of explosion vents depends upon the expected intensity of an explosion, the strength of the structure, the type of vent closure and other factors. **NFPA No. 63, from Sec. "Venting".**

Terminal Grain Elevator, Port Arthur, Ont., Sept. 24, 1952; 6 killed, $4,000,000

Six men were killed and 14 were injured in an explosion of grain dust from refuse screenings that occurred while the screenings were being spouted into a ship tied up beside the 10-story reinforced concrete work house. Screenings were being transferred from two of a large group of grain tanks in a detached annex to the work house via basement conveyors, then via legs to the top of two shipping bins in the work house and via spouts from the bins to the ship.

The primary explosion apparently occurred in one of the two shipping bins in the work house. The explosion blew out one side of the bin and threw dust in the dusty building into suspension. Secondary explosions traveled through conveyor galleries to the storage bin annex where the roof above the open topped concrete bins was blown off. Small fires broke out in ventilators, elevators, bins, etc., but at no time presented a serious problem. Access for rescue and fire fighting was greatly aided by enclosed stairways and outside fire escapes.

Cause of the explosion was not determined. No screenings were entering the shipping bins and both bins were supposedly empty when the explosion occurred.

Dust on floors and other surfaces, including all galleries and tunnels, shall be removed daily by sweeper.

As many sweepers shall be employed as are necessary to keep the building clean. **NFPA 61B, Secs. 6011 and 6013.**

Feed Mill, Cedar Rapids, Iowa, Jan. 19, 1953; $85,000

Failure of employees to shut down oat grinding machinery immediately on the detection of the odor of smoke proved to be a serious oversight. While employees were trying to locate the source of the smoke, sparks apparently were carried through the dust collecting system to the collector on the roof of the four-story building where an explosion occurred several minutes after smoke was first detected.

The explosion extended to the top stories of two adjoining buildings through dust collecting ducts. Distortion of a wall and raising of the roof of one of the buildings suggested that a second more violent explosion had occurred in the top story of this building. Fortunately it was not severe enough to rupture sprinkler piping since

fires that broke out were quickly extinguished by sprinklers.

Explosion relief vents should be provided on all duct systems used for conveying materials which form an explosive mixture with air. Explosion vents shall have a cross-sectional area not less than the cross sectional area of the duct vented.

Explosion relief vents for ducts should lead by the most direct practical route to the outside of the building and should not deviate more than 22½° from the direction of the duct from which they lead. **NFPA No. 91, from Secs. 451 and 452.**

TERMINAL GRAIN ELEVATOR, NEAR HUTCHINSON, KAN., FEB. 4, 1953; 3 KILLED, $125,000

This dust explosion which took three lives and injured three others occurred during maintenance and cleanup operations. Origin was believed to have been in an elevator leg in which some new buckets had just been installed. A friction spark by an improperly installed bucket or a tool left in the leg may have been the ignition source. The explosion vented itself into a basement tunnel where a high concentration of dust was probably present due to the cleanup operations. A more violent explosion occurred that blew out the ends of the tunnel, traveled up through the 450-ft.-high head house, blowing out one entire side of the head house and blowing a hole in the roof, and extending laterally the full length of the gallery on the top of the tanks. Other damage included demolition of the unloading pit and rupture of the bottom of some of the tank.

There were no dust collecting systems in the elevator but a suction fan was located at each end of the gallery.

Elevator and storage annexes shall, insofar as is possible, be built enough above ground so that all basement belt tunnels or other basement work areas as well as galleries above tanks can be provided with at least the minimum ventilation and explosion vent areas, direct to the outside, as recommended in Section 1034 for venting of work areas. Also see Articles 201 and 202. **NFPA No. 61B, Sec. 1081.**

TERMINAL GRAIN ELEVATOR, FREDERICK, OKLA., FEB. 7, 1953; $65,000

This dust explosion occurred while employees were cleaning out the pit. Dust and debris was shoveled into the grain elevator, conveyed to the top of the elevator where it was dropped down a spout to a truck.

Lack of an outside fire escape hampered efforts of fire fighters to get water on the ensuing fire in the head house.

An exterior fire escape of the stair or basket ladder type shall be provided from the roof of the work house to ground level or to roof of an adjoining annex with access from all floors above the first. Fire escape doors shall swing with the exit travel. **NFPA No. 61B, Sec. 1103.**

FEED MILL, NEAR PUENTE, CALIF., SEPT. 20, 1954; $215,000

On two occasions during the weekend the watchman had discovered and extinguished small fires in a grain bin but in neither instance had he called the fire department to be sure the fires were out and to investigate the cause. This oversight was costly since the third fire was not discovered until a dust explosion shook the 3-story wood-framed, metalclad building. In a short time fire spread throughout the unsprinklered mill.

The watchman should be instructed, in case of fire, to always call the municipal fire department first before trying to extinguish a fire. He should not assume that the extinguishing apparatus on hand will be sufficient to extinguish the fire. It is better to call the municipal fire department when it is not needed than to waste valuable time trying to extinguish the fire first, only to find out that the fire is out of control. **NFPA No. 601, Sec. 202.**

Lacquer and Wood Dust

BOWLING ALLEY, PEORIA, ILL., MAY 17, 1945; 1 KILLED, $2,000

This dust explosion occurred in a cloth dust collecting bag on a sanding machine being used to remove lacquer finish from bowling alleys prior to refinishing. Cause of the explosion may have been sparks drawn into the bag when the sanding machine struck a nail on the floor. Burning lacquer and wood dust blown about by the explosion fatally burned the workman and set fire to the unsanded part of the floor but before flames could make much headway nine sprinklers had operated and extinguished the fire.

Leather, Wood and Plastic Dust

SHOE FACTORY, FAIRFIELD, PA., AUG. 2, 1953; $500,000

Fire that apparently originated with an explosion in the dust collection system just after the watchman made his hourly inspection, spread rapidly over the combustible fibreboard ceiling and wall finish. (Dusts generated in the plant were wood, leather and plastic.) Flames were beyond control in the undivided and unsprinklered 28,125 sq. ft. 1-story wood-framed, metalclad building when firemen arrived. The severe handicap to fire fighters caused by lack of water once

again reminded townspeople of the need for a system of water mains.

Buildings in which materials producing flammable dusts are stored or handled should be detached units of noncombustible construction, including inside partitions. Room interiors and equipment should be smooth and easy to clean. Walls should preferably be finished in glossy enamel **NFPA No. 63, from Sec. "Building Construction".**

Lignin Dust

PAPER MILL (LIGNIN RECOVERY), CORNWALL, ONT., APRIL 21, 1951

Smoldering lignin dust that had accumulated on steam coils in a lignin flash drier was the probable cause of an explosion of lignin dust in the drier. Explosion pressures burst open the drier and were released from the unsprinklered noncombustible building by blowing out the corrugated cement asbestos walls of the roof monitor. Windows in the vicinity of the equipment were also blown out. Heat from the explosion and ensuing fire in a wooden partition caused 16 sprinklers in an adjoining building to operate before the automatic closing fire door between the two buildings shut.

Arrangements shall be made for periodic inspection of the drier interior and it shall be cleaned as necessary. **NFPA No. 93, Sec. 11-2.**

Nicotinic Acid Dust

DRUG MFG., LANSING, MICH., SEPT. 16, 1954; $150,000

Following explosion of nicotinic acid dust in a grinding mill on the first floor, fire enveloped the machine and spread with great rapidity through the dusty interior of the unsprinklered 17,500 sq. ft. 2-story wooden building. Foreign metal in the grinding mill was the cause of the explosion. The five employees on the first floor ran outdoors at once and were uninjured. The only employee on the second floor remained inside 1½ minutes and suffered facial burns before jumping from a second story window. On the advice of the State Health Department, which had on file a list of chemicals at the plant, an area two blocks wide on each side of the fire was evacuated because of the possibility that toxic gases would be evolved. Fire fighters elected to stay on the job and from the windward side wet down exposed tanks of chemicals and prevented spread to adjacent buildings.

The building was undivided except for a storage room which was cut off from the rest of the building by a fire wall. The room and its contents of nicotinic acid valued at $50,000 was undamaged.

Restrict hazardous areas by subdivision with substantial walls resistant to fire and pressure and avoid direct communication with other areas. Cut off stairs and elevators from important areas by fire walls and fire doors, or locate outside with communication through openings protected by fire doors. **NFPA No. 63, from Sec. "Building Construction".**

Oat Bran Dust

FEED MILL, PETERBOROUGH, ONT., JAN. 12, 1953; 1 KILLED, $56,500

At 8:03 A.M., as the plant was starting up, a dust explosion (some reports indicate two explosions) occurred in the eighth story of the sprinklered 8-story fire-resistive feed mill. All six

Nicotinic acid dust explosion, Lansing, Mich., Sept. 16, 1954. — This explosion illustrates the fact that any combustible material in a finely divided state can be exploded when suspended in air in the proper concentrations.

employees in the eighth story were injured and one later succumbed. If there were two explosions, the first may have occurred in one of six partially filled bins that extended from the eighth to the fifth stories. These bins contained oat bran, shorts and middlings. This explosion could have vented itself into the top story, throwing dust into suspension and causing the second more violent explosion.

The explosion traveled through elevator legs and through other vertical openings causing varying degrees of damage on each of the upper seven stories. A fire wall with double fire doors at all doorways separated the feed mill from the flour mill. Doors on the feed mill side in the seventh and eighth stories were open at the time of the explosion. The explosion blew off the doors on the flour mill side venting itself into the flour mill. Numerous window panes in the seventh and eighth stories of the feed and flour mills also were blown out and provided pressure relief.

A painstaking investigation revealed three possible ignition sources: 1, a spark from a piece of 1 15/16-in. shafting, 10½ inches long that was found in a rotary sifter in the eighth story; 2, rubbing the side of the boot by a pulley in an elevator leg that showed evidence of an explosion; 3, a blower fan motor connected to a dust separator on the eighth story. This motor and switch were the only electrical equipment in the explosion area not suitable for Class II locations (hazardous because of the presence of combustible dust).

Fires broke out in isolated places but because of the fire-resistive construction of the building and the prompt operation of sprinklers fire damage was negligible.

Door openings in masonry fire walls shall be equipped with approved Class "A" fire doors . . . Doors shall be self-closing. **NFPA No. 61C, from Sec. 1053.**

Paper Dust

PAPER CONTAINER MFG., BALTIMORE, MD., MAY 27, 1954

A piece of metal that was drawn into a dust collector caused an explosion of paper lint in the collection system when it struck fan blades. Three sprinklers in the vicinity of the collector extinguished fires that broke out, and transmitted the alarm to the fire department by means of a central-station-connected waterflow alarm.

Systems collecting highly flammable or explosive dust preferably should be so arranged that the fan is on the clean air side of the collector. **NFPA No. 91, Sec. 411.**

Peanut Hull Dust

PEANUT SHELLING PLANT, STEPHENVILLE, TEXAS, Nov. 24, 1949; $375,000

Fire that was started in the yard by a tramp to warm himself spread through dry grass and into one end of the hull warehouse where it was discovered by the night watchman. The fire department was telephoned at once but before the fire could be attacked several small dust explosions occurred that spread flames throughout the building.

Adequate protection requires complete coverage of all plant property. . . . Enough watchmen should be provided so that each man can cover his assigned route in forty minutes, allowing ample time to check valves, windows, doors, lights, etc. **NFPA No. 601, from Sec. 71.**

Phthalic Anhydride

CHEMICAL PLANT, BRIDGEVILLE, PA., MAY 12, 1950; $200,000

Three explosions within a few seconds of each other caused extensive damage to the roof and windows of the high 1-story noncombustible building, and varying degrees of damage to condensers and fume towers. Although sprinkler piping was broken by the explosion, impairment of protection was not a major factor since the ensuing fire was in equipment.

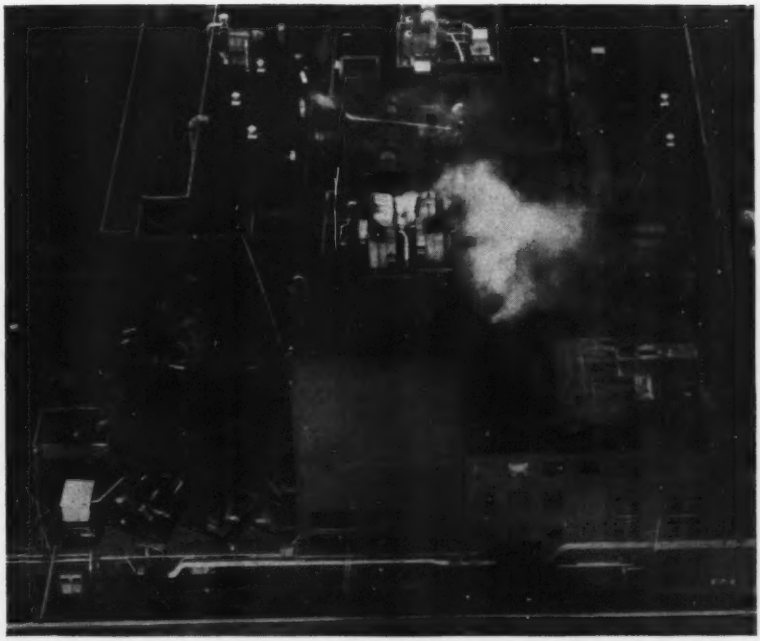
The initial moderate explosion is believed to have involved phthalic anhydride vapors in a melt tank. The subsequent more violent explosions are attributed to ignition of combustible dust (probably phthalic anhydride) on building surfaces and in condensers, dispersed by the first blast.

Good housekeeping is essential. Well-designed equipment reduces necessary cleaning, but it is not always possible to maintain absolutely tight systems. Vacuum cleaning is preferable although soft push brooms may be used without serious hazard except where dust brushed from ledges may form explosive clouds in air. **NFPA No. 63, from Sec. "Housekeeping".**

Plastic Dust

PLASTIC MFG., BOUND BROOK, N. J., MARCH 14, 1944; $400

A dust explosion in a blender of phenol resin molding material was probably ignited by a bearing that had overheated because of dried out packing. The explosion traveled through connecting duct work to a tumbler on the floor above where a second explosion occurred. The explosion pressure was released through vents in the room without damage to the tumbler. However,



Plastic dust explosion, Bound Brook, N. J., Dec. 22, 1952. — Five employees were killed in a series of dust explosions that started with one in a hammer mill. Explosion pressures traveled through ducts to other areas of the building where dust was thrown into suspension and exploded violently.

when the explosion vented itself into the room it bent window sash and broke several windows.

Explosion relief vents shall be of such size and design as to prevent rupture of the device or apparatus protected (see Appendix). The explosion vent ducts shall be properly designed, substantially constructed of metal and be carried out-of-doors as directly as possible, avoiding sharp turns — never through an adjoining building or room. **NFPA No. 654, Sec. 706.**

PLASTIC MFG., INDIAN ORCHARD, MASS., JUNE 29, 1948; $1,000

Smoldering ignition of phenolic molding powder that had collected between a worn bearing and the hammer mill housing was the probable cause of fire at a hammer mill. Glowing particles of powder were carried pneumatically to the metal-enclosed cloth bag dust collector on the roof where a dust explosion occurred.

When the explosion occurred, two self-closing explosion vents in the top of the collector opened to relieve the pressure and then immediately closed, dampers at the inlet and outlet of the collector closed automatically, the automatic carbon dioxide system operated and extinguished smoldering fire in the collector and a fire alarm was sounded.

All apparatus should be properly and securely installed to insure constant true alignment and to avoid hot bearings or friction, and no moving parts such as belts, pulleys, drive chains, etc., shall be fitted close to or come in contact with any part of the enclosures or the structure. **NFPA No. 654, from Sec. 501.**

PLASTIC MFG., BELLEVILLE, ONT., APRIL 13, 1950; $1,400

Before phenolic molding material was introduced into a micropulverizer inert gas was passed into the pulverizer until a constant inert atmosphere was obtained.

Conditions were considered safe for pulverizing when a gauge attached to the gas line near the pulverizer gave a constant reading. On this

particular occasion the inert atmosphere was not present in the pulverizer despite a constant pressure gauge reading since a dust explosion occurred that damaged several pieces of interconnected equipment. Windows, doors and electrical equipment were broken when the explosion vented itself into the building through a vent on a blender.

Investigators found the inert gas line between the gauge and the pulverizer plugged with powder and believe this condition accounted for the absence of an inert atmosphere in the pulverizer despite the constant pressure reading on the gauge.

***Suitable analyzing (indicating or recording) equipment shall be provided to indicate the quantity and quality of the inert gas available. Some of the factors which may require measurement are: pressure, temperature, rate of flow, dew point, oxygen content, and purity. Purity is determined by measuring such undesired contaminants as may be present.* NFPA No. 69, Sec. 352.**

PLASTICS MFG., INDIAN ORCHARD, MASS., JULY 22, 1952; 2 KILLED, $11,750

Foreign material in a phenolic resin lump crusher was the probable cause of a flash fire that fatally injured an employee working at the crusher. The pressure wave that preceded the flash fire through dust collecting ducts to the mill room raised dusts from beams, flooring and machinery which exploded violently. An employee was killed, two others were injured and major building damage resulted because of absence of adequate explosion venting facilities in the mill room.

All of the stock delivered to the mills shall pass over magnetic separators of the self-cleaning type interlocked with the grinder drive, and the stock shall be protected against the entry of foreign materials in its passage to the mills.

***Explosion venting shall be provided in a given room or space in which dry powders are processed.* NFPA No. 654, from Secs. 505 and 303.**

PLASTIC MFG., BOUND BROOK, N. J., DEC. 22, 1952; 5 KILLED, $489,400

Overheating of a bearing on a hammer mill is believed to have caused molding powder to smolder. Hot particles were carried to the dust collector where a dust explosion occurred. Explosion pressures traveled through ducts to certain floor areas where static dust was thrown into suspension and exploded violently. This latter explosion killed five employees, injured 21 others and caused most of the extensive damage suffered by the 4-story building.

***Good housekeeping is an extremely important factor; apparatus which will not leak and permit the escape of dust or sifting out of the material is essential Accumulations of dust shall not be tolerated in the building.* NFPA No. 654, from Sec. 801.**

Rayon Dust

TEXTILE MILL, AGAWAM, MASS., JAN. 30, 1947; 1 KILLED, $2,000

While clean garnetted rayon stock was being blown from an opening picker to a 12 ft. by 11 ft. wooden storage bin an explosion occurred in the bin. The wooden bin door was blown against a piece of equipment 18 feet away, bin partitions were bulged and a pressure wave of hot gases traveled through the building burning three employees, one fatally, and igniting stock and other combustible material. All fires were quickly extinguished by fourteen sprinklers, an extinguisher, and one fire department hose stream.

Lighting for the bin consisted of an unprotected light bulb on an extension cord. This light was said to have been removed from the bin whenever rayon stock was introduced. If this was actually done on this occasion, the most probable explanation of the explosion was ignition of a suspension of finely divided rayon fibres by sparks from foreign material (metal or match) that passed through the picker.

***When venting a room, building, or piece of equipment, consideration must be given to the location into which an explosion is to be vented, in order to prevent damage to exposures and injury to personnel. In congested locations, substantial ducts or diverters should be provided to direct the blast.* NFPA No. 68, from Sec. "Important Basic Recommendations".**

Rubber Dust

TIRE RECAPPING, MADISON, IND., JUNE 19, 1954; $20,000

A spark from a cigarette lighter that fell from the pocket of an employee started a fire in a pile of rubber dust and shavings. As the employee went for a bucket of water a minor dust explosion occurred that spread the fire beyond control in the basement of the unsprinklered 3-story brick, wood-joisted building.

***Eliminate all sources of ignition because many dusts can be ignited by very low energy sparks. Prohibit open flames or lights, and smoking.* NFPA No. 63, from Sec. "Sources of Ignition".**

Soap Dust

SOAP MFG., QUINCY, MASS., NOV. 7, 1953; $5,000

An acetylene cutting torch being used to remove a baffle from a duct near the top of the 100-ft.-high

soap processing tower ignited a residue of soap within the duct. When attempts by employees to put out the fire failed the fire department was called. Before public hose streams could be placed in operation a dust explosion occurred at the top of the tower that broke wired glass windows. Fire then spread to the control room where it was controlled with a hose line operated from an aerial ladder and with interior standpipe lines.

***Avoid the use of any welding or flame-cutting equipment for construction or repair work unless the vicinity of the work is entirely dust-free.* NFPA No. 63, from Sec. "Sources of Ignition".**

Soybean Dust

FLOUR MILL, PEORIA, ILL., MAY 11, 1943; $16,000

Soybeans were ground in an attrition mill in the third story of a 3-story building, the flour being blown to a cyclone collector in the fourth story of an adjoining 4-story building. From the collector it was spouted to another attrition mill in the first story.

Noticing a smoldering fire in the first attrition mill, employees shut down the mill but allowed the fan that blew the flour to the collector to continue running. Other employees at the collector hastily disconnected the outlet duct and allowed the flour to discharge on the floor. This procedure was followed to prevent burning flour from traveling beyond the collector to the next attrition mill and had been carried out many times in the past without an accident. On this occasion an explosion occurred in the collector as the flour was being discharged on the floor. Two employees were burned by the fire that flashed through the fourth story. The blaze was extinguished by the 36 sprinklers that were opened.

Investigators learned that the magnetic separator ahead of the attrition mill was not in operation at the time of the explosion, leading them to believe that a piece of tramp metal had entered the mill.

***Dust collectors should preferably be of all-metal type which shall be located outside of buildings or shall be equipped with exhaust stacks or ducts leading to the outside air.* NFPA No. 61C, Sec. 5052.**

SOYBEAN OIL MILL, ST. LOUIS, MO., FEB. 25, 1945; $32,500

An explosion of soybean dust in the settling collector in the fifth floor of this 5-story fire-resistive expeller type extraction mill was believed caused by sparks from a hammer mill which was grinding soybean press cake into meal.

Flames that shot out of the ruptured settling collector ignited sacked feed nearby, singed the eyebrows of an employee 20 ft. away, flashed to a bag hoist where it extended to the fifth story level before automatic doors on the hoist shaft could operate. The explosion also traveled from the settling collector through 75 ft. of 2-ft.-diameter piping to stocking type collectors on the roof where a second explosion occurred. As the explosion flashed through the piping between the two collectors several hand hole covers were blown off, and in at least one instance flames from the hand hole opening ignited sacked feed.

Sprinklers operated promptly on all floors and were allowed to operate until scattered smoldering fires were extinguished and a careful check was made of all conveyors and spouting. The fire in the unsprinklered collector on the roof was extinguished with hose streams.

Magnetic separator protection was provided when the beans entered storage bins and ahead of roller mills but none was provided ahead of the press cake hammer mill to remove broken metal from equipment. Shortly after the explosion a battered piece of hot metal was found in such a position as to indicate it had passed through the hammer mill. It was also discovered that a bolt was missing from a conveyor leading to the hammer mill.

***Approved permanent magnets or approved self-cleaning electro-magnetic or pneumatic separators should be installed in an approved manner ahead of all shellers, crackers, crushers and grinding machinery.* NFPA No. 61C, Sec. 3091.**

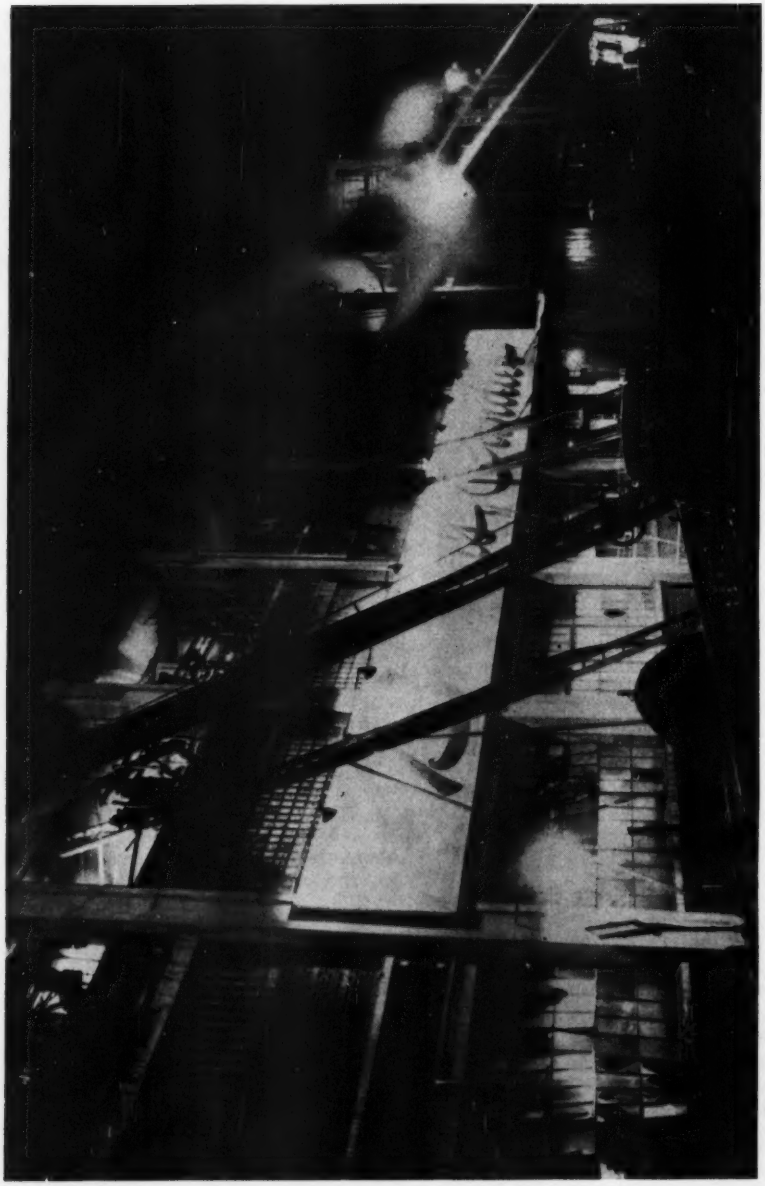
Sponge Iron Dust

POWDERED METAL MFG., JOHNSTOWN, PA., JAN. 16, 1951; 1 KILLED, $25,000

An employee was fatally burned in an explosion that occurred in a cone blender on which another employee was doing some welding. The explosion involved sponge iron dust. Between 4,000 and 6,000 pounds of burning sponge iron powder in the blender at the time were blown out of the loading opening (in the open position at the time) in the top of the blender setting fire to the wood roof overhead. Although a large part of the roof was damaged efficient work by the plant fire brigade prevented spread to the rest of the unsprinklered building.

Of the several possible causes of the explosion the most plausible is that a spark from the welding operation entered the blender either through the crack being repaired or through the loading opening.

Avoid the use of any welding or flame-cutting equipment for construction or repair work unless the



Starch dust explosion, Chicago, Ill., Sept. 7, 1948. — The NFPA Code for the Prevention of Dust Explosions in Confectionery Manufacturing Plants was drafted as a result of this disastrous explosion that took 15 lives. Three explosions occurred, the first in a candy molding machine when the machine was started up Monday morning. The ignition source was believed to have been starch that had smoldered in the attached drier over the weekend.

***vicinity of the work is entirely dust-free.* NFPA No. 63, from Sec. "Sources of Ignition".**

Starch Dust

SPICE MILL, MONTREAL, QUE., OCT. 8, 1946

A dust explosion occurred in a large mixing tank in the third story into which a mixture of powdered cornstarch and sugar was being introduced from a hopper in the fourth story. As it entered the tank the mixture passed through a metal screen over which a rotary fibre brush passed. Ignition of the dust cloud in the tank may have been by a static spark generated by the rubbing of the rotary brush on the ungrounded screen or may have been due to a friction spark caused by foreign material in the mixture. The ensuing fire in the vicinity of the mixing tank was extinguished by one sprinkler.

***Static electricity shall be removed from such machines as accumulate a charge by permanent ground wires, and from belts by grounded metal combs or other equally efficient systems.* NFPA No. 61A, Sec. 84.**

CANDY FACTORY, CHICAGO, ILL., SEPT. 7, 1948; 15 KILLED, $2,000,000

The first of three starch dust explosions that killed 15 employees, injured 10 and caused $2,000,000 property damage originated in a machine used in a continuous candy making process. Starch used in the molding of cream fillings at the machine was conveyed to a drier to remove moisture after which it was returned to the machine for reuse. Apparently starch in the drier had ignited and smoldered over the week end (the explosions occurred as the day's operations were starting) and smoldering dust was carried into the candy molding machines when the fans in the dust conveying ducts were started.

The first explosion in the machine, although mild, was sufficient to shake dust loose in the machine which exploded with greater violence. Dust thrown into suspension resulted in a third and more violent explosion, which blew out brick panel walls and windows in the third and fourth stories of the fire-resistive building, wrecked sprinkler piping and started numerous fires.

It is recommended that the head plate, or inspection door be removed at regular intervals, preferably weekly, and the interior of dryer heads cleaned and inspected.

***All surfaces on which dust settles shall be cleaned off sufficiently often to prevent the accumulation of a coating of dust.* NFPA No. 657, Secs. 2043 and 2061.**

POTATO STARCH FACTORY, VAN BUREN, MAINE, MARCH 28, 1953; $51,000

The attic and roof of this 1-story wooden factory were damaged by fire that originated with a potato starch dust explosion in a wooden 20 ft. by 25 ft. dust collecting room in the attic.

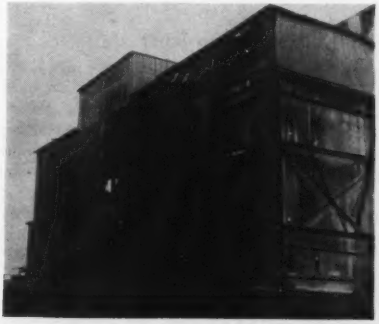
After potatoes were mashed, settled and dried in the first story drier, starch was transferred by a blower system to the attic of the sprinklered 1-story building where it was collected in an unsprinklered 20 ft. by 25 ft. dust collecting room. The starch was then sifted. A violent dust explosion occurred in the dust collecting room that blew out an exterior attic wall, lifted the roof, wrecked the sprinkler system and dislodged dust which ignited in a second explosion. Forty-two sprinklers operating in the first story confined the ensuing fire to the attic until it was extinguished by fire department hose streams.

Investigators found a metal screw lodged in the blower fan, suggesting that a friction spark was the cause of the initial explosion. No magnetic separators were provided and the blower fan was constructed of ferrous metal. Another serious weakness was the absence of explosion vents from the dust collecting room.

***All hoppers for bulk starch shall be provided with an explosion relief panel in one wall, or in the top, with area equal to at least one-third the horizontal cross-section of the hopper. This panel shall be built so as to give way to outside of the building.* NFPA No. 61A, from Sec. 32.**

WHEAT STARCH MILL, HARBOR BEACH, MICH., AUG. 16, 1953; 1 KILLED, $51,650

An employee suffered fatal burns and two others were injured in a dried wheat paste dust



Starch dust explosion, Harbor Beach, Mich., Aug. 16, 1953. — Sparks created when a foreign metal object entered an air separator and struck the fan blades.

explosion in an air separator. Sparks created when a foreign metal object entered the air separator and struck the fan blades, igniting the dust cloud. Fire flashed through the grinding and roll rooms opening 207 sprinklers. These and the plant fire brigade brought the fire quickly under control.

All starch before milling shall pass a one-half or smaller mesh screen, and approved magnetic separators, or shall be raised by air lift.

The grinding chambers and all parts within the grinding chambers of the mills should be of brass, bronze, or other non-sparking metals. **NFPA No. 61A, Secs. 33 and 34.**

Sugar Beet Pulp Dust

BEET SUGAR REFINERY, ALMA, MICH., OCT. 18, 1945; $100,000

Fifteen hours after the annual beet processing program began at this sugar refining plant a dust explosion occurred in a dust collector located in the building. Fire scattered throughout the building by the explosion necessitated abandonment of operations and layoff of 350 seasonal workers.

The collector in which the explosion occurred collected dust drawn from a beet pulp drier. Just prior to the explosion the collector had become clogged. Apparently the cloud of dust stirred up by employees in their efforts to free the choke was ignited by a smoldering dust particle.

Locate dust collectors preferably outdoors, or in detached rooms with adequate explosion vents for collectors and rooms. **NFPA No. 63, from Sec. "Dust Collectors".**

Sulfur Dust

PAPER MILL, BUCKSPORT, MAINE, NOV. 9, 1936; 2 KILLED, $500

Two workmen who were removing sulfur from a nearly empty sulfur silo were killed by a sulfur dust explosion. It was reported that dust in suspension was ignited when the conveyor belt broke on coal-handling equipment being used by the men to remove the sulfur.

All elevators and conveyors which agitate the sulfur being transported (such as bucket elevators and screw conveyors) shall be enclosed in dust-tight casings, and shall be equipped with explosion relief vents. . . .Non-ferrous buckets or bucket conveyors should be used where these are in ferrous casings. **NFPA No. 655, from Sec. 315.**

Wood Dust

WOODWORKING PLANT, ORILLIA, ONT., JUNE 3, 1950

Failure to provide a choke in the feed pipe allowed a wood dust explosion that originated in the combustion box of the steam boiler to spread through the feed pipe to the magazine where shavings were ignited. Following this experience the plant management installed a worm feed.

The discharge from feed magazines to furnaces shall be so designed that either by means of a choke feeder or choke conveyor a positive cut-off is provided between the furnace and the magazines. **NFPA No. 663, from Sec. 331.**

WOOD DOOR MFG., WINGHAM, ONT., FEB. 17, 1951; $8,600

A dust explosion occurred in a shavings vault while an employee was inside the vault cleaning it out. The explosion injured the employee, blew out a wall of the unvented vault and ignited dust that had accumulated on steam pipes in the first and second stories of the building. Approximately 70 sprinklers held the fire in check until it was extinguished by the town's volunteer fire department.

Breaking of an extension light bulb in the vault was the probable cause of ignition of the dust cloud.

Neither open lights nor electric extension cord lights shall be used in the vaults or magazines. **NFPA No. 663, Sec. 521.**

SHINGLE MILL, ELMA, WASH., AUG. 14, 1953; $10,000

Friction at a pulley was the probable cause of fire that ignited a large amount of dust that had been allowed to accumulate on the floor. When an employee attempted to extinguish the blaze with a garden hose stream, dust was thrown into suspension and exploded after which fire spread throughout the unsprinklered 2-story wooden building.

Firemen had to dam a creek before water could be obtained for fire fighting.

Caution: Finely divided water spray nozzles or a combination of finely divided water spray nozzles and straight hose streams are recommended, as careless and unnecessary use of straight hose streams may cause dust explosions by throwing dust into suspension.

In view of the large amount of combustible material in this type of plant, full automatic sprinkler protection for the entire property is recommended, including the interior of collectors and vaults in the wood waste handling system. **NFPA No. 663, from Secs. 612 and 621.**

Wood dust explosion, North St. Paul, Minn., Dec. 3, 1953. — An explosion in a boiler while it was being hand fired with sawdust entered the sawdust bin when another dust explosion occurred. The fireman was killed, the bin roof was blown off and fire broke out that eventually destroyed five buildings.

SKI MFG., NORTH ST. PAUL, MINN., DEC. 3, 1953; 1 KILLED, $500,000

A wood dust explosion killed the plant engineer, wrecked sprinkler piping and the boiler room roof, and caused fire that destroyed five adjoining and communicating 1- to 4-story buildings of mixed construction. The explosion occurred at 5:20 A.M., just after the engineer had come on duty to fire up the boiler for the day's work.

Since the engineer was killed it can only be surmised that while he was hand-firing the boiler with sawdust, a flash back occurred that caused a dust explosion in the adjacent sawdust bin.

Firemen summoned by a neighbor found part of the roof of the 1-story boiler room and sawdust bin blown off, dust collectors on the roof collapsed, and fire of considerable magnitude on the upper stories of two adjoining 4-story buildings. Fire had entered these buildings through windows broken by the explosion and overlooking the boiler room. Damage to sprinkler piping in the boiler room depleted all sprinklers of water. Flames spread unchecked through the interconnected buildings as fire fighters tried unsuccessfully to bring them under control with a poor water supply from a 4-inch city main.

If the finely divided wood particles are to be used as fuel, the vault, or vaults, should discharge through a conveyor to magazines at each furnace where the wood fuel is to be used. The discharge system shall be so designed that either by means of a choke feeder or choke conveyor a positive cut-off is provided to prevent a flashback from the magazine to the vault. **NFPA No. 663, from Sec. 322.**

SAWDUST STORAGE AND BAGGING, LYNN, MASS., JULY 26, 1955

While sawdust was being transferred from a truck to a conveyor by a bucket-type lift truck, fire flashed beneath the ceiling of the dusty first story to the storage room where a dust explosion bulged one of the cinder block walls. Fires in the dusty building were held in check by 50 sprinklers and extinguished by fire department hose streams. A friction spark generated by the steel bucket of the lift truck may have been the ignition source.

In sections of the plant where dust accumulates or is present in suspension in the air, explosion venting shall be provided in a portion of the exterior wall (or walls). **NFPA No. 663, Sec. 131.**

Wood Flour Dust

WOOD FLOUR MFG., SOUTH PARIS, MAINE, FEB. 16, 1951; 4 KILLED, $240,000

Four of the five employees in the 6,000 sq. ft. 1-, 2- and 3-story plank on timber building were killed when fire flashed through the building and was immediately followed by a wood dust explosion that raised the roof and blew out walls. Fire fighters managed to prevent involvement of exposed buildings despite a serious water shortage because of escape of water from explosion-damaged sprinkler piping until the control valve could be closed and because of failure of the plant's electric fire pump when wires passing the building were destroyed.

Due to the extent of damage and casualties no information was forthcoming on the probable cause. However, the extent of damage may be explained by dust conditions in the building, and the absence of explosion vents. Rough unpainted interior surfaces of the building permitted large accumulations of wood dust. In the process used, ground wood flour was pulverized at mills and then conveyed pneumatically to heavily constructed wooden bins, each approximately 300 sq. ft. in area and 20 ft. high. These bins were located in the top story of the building and, like the building itself, were not equipped with explosion vents.

A portion of the exterior walls in the ratio of not less than 1 sq. ft. of wall surface for each 80 cu. ft. of volume in a given room shall be composed either of light noncombustible material, preferably 1/8 in. thin glass, or of automatic venting devices in the form of hinged windows or panels so balanced as to open under a predetermined pressure.

Good housekeeping is one of the most important factors; apparatus which will not leak and permit the escape of dust or sifting out of the material is essential. Accumulations of dust shall not be tolerated in the building. It is recommended that the interior of the pulverizing department be painted a color which is in contrast with that of the dust. **NFPA No. 662, Secs. 23 (a) and 61 (a).**

WOOD FLOUR MFG., WINDHAM, MAINE, JAN. 14, 1955; $2,000

Foreign material that entered an attrition mill with sawdust was the probable cause of a dust explosion in the mill. The explosion traveled through ducts to sifters and other interconnected processing equipment, blowing out all explosion vents and opening 80 sprinklers in dust collectors, ducts and equipment and at the roof of the 1-story building. Open sprinklers in storage bins functioned efficiently when water was turned on by manual operation of a quick opening valve.

The buildings or rooms in which the processes of pulverizing are carried on shall be protected by a system of approved automatic sprinklers and shall be equipped with approved first aid fire appliances, together with approved small hose. **NFPA No. 662, from Sec. 71.**

WOOD FLOUR MFG., WINCHESTER, N. H., FEB. 27, 1956; $2,000

Wood flour at this plant was dried in a direct oil-fired rotary drier of a type commonly found in cereal mills and in which drying was accomplished by passing the products of combustion through the drier. Failure of the oil burner to ignite properly on a normal operating cycle caused partial flooding of the fire box. A backfire at the time of the next automatic ignition entered the drying chamber and ignited wood flour. The dust explosion that immediately followed ruptured air ducts and vented itself into the drier room by rupturing a small cyclone collector on one end of the drier. The top six rows of concrete blocks of a division wall were blown out and fires broke out in dust in the drier room. These were extinguished by six sprinklers. Smoldering fires in ducts were put out by careful use of 1½-inch hoses equipped with spray nozzles.

Driers should preferably be heated indirectly as the use of direct fired driers presents greater hazard.

Automatic recycling type control equipment shall not be employed. **NFPA No. 93, Secs. 6-1 (a) and 9-2 (a).**

DUST EXPLOSIONS — PHOTO CREDITS

Page 217, Press Association; page 219, Bureau of Mines; page 221, United Press; page 223, Al Munson; page 226, Atlas Photo Engraving; page 229, News Chronicle; 230, both photos, Oregon State Fire Marshal; 233, Fort Worth Star-Telegram; 237, Associated Press; 240, Wide World; 243 Associated Press.

The Adoption of Standards in Law

By Robert S. Moulton

Technical Secretary, National Fire Protection Association

How can we adopt NFPA standards in law, by reference, automatically keeping them up to date? This question is asked frequently of the NFPA Executive Office by men who feel the need for state or municipal regulation of certain fire hazards in the interest of public safety, and who wish to utilize generally accepted National standards as a basis.

The answer is surprisingly simple, for those who will accept it. It is to appoint a fire marshal or other official charged with similar duties, and then specify that no one shall maintain a fire hazard. A very brief law will suffice if handled on this basis.

Under this plan, it is the responsibility of the fire marshal to determine what is a fire hazard, and how it should be dealt with. The fire marshal will find quickly that his best method of operation is to rely for guidance upon published National standards. He should let it be known which standards he proposes to use, and make copies available for reference in his office. In this way, the up-to-date edition of standards can always be utilized. Furthermore, this plan, with no mention of the standards in the law itself, seems completely legal in all jurisdictions.

The difficulty with this plan is that it may take in too much territory, and that in the hands of an incompetent or dishonest official it may not work at all. The answer, of course, is to appoint only competent and honest officials. With incompetent or dishonest officials the results will be unsatisfactory no matter what the law says. If a blanket authority to control fire hazards is considered too broad, the power of the official may be circumscribed by spelling out in detail just what he shall handle.

Will Correct Standards Be Used?

Whether the official will select the correct standards and apply them intelligently is a matter largely determined by his competence. In the absence of instructions, he may adopt the wrong standards, or amend existing National standards to suit his own ideas. The chances are, however, that he will be forced to use the correct standard and will not amend it, because any other course of action could subject him to all sorts of commercial pressures. In any case, the chances of satisfactory results seem just as good by this method as by any other.

The reasonableness of any standard adopted by reference, no matter by what method, is the determining factor in its application. Courts will generally approve anything which seems reasonable. There should be some provisions in any legislation for review by the courts and preferably for review by some Board of Appeals prior to taking the matter into court. Many controversial cases can be settled through such an appeal procedure.

This discussion would not be complete without some reference to licensing of installers or permits for the installation of flammable liquids. A system of licensing and permits is convenient, but it scarcely seems necessary as regards licensing — except, perhaps, for some special features such as fumigation where it is essential to maintain very rigid control over the operations

which might cause serious hazard to life. Ordinary permit provisions are an aid to enforcement, and should be attended by fees sufficient to cover the cost of operations.

Adoption of Complete Standards in Law

For those who do not want to follow the simple method outlined above, there are various other methods of adopting standards by reference.

The time-honored and original method is to adopt the entire text of the standard in law. This is not too bad as far as some simple laws are concerned, but when we get into the more complex ramifications of flammable liquids, chemicals and explosives and other special features, the adoption of a detailed law is quite out of the question from the point of view of printing expense, if for no other. Large cities can perhaps afford the printing expense, but in general it is undesirable from the point of view of revisions. New York City adopted the National Electrical Code and printed it verbatim in 1913, continuing the 1913 code for many, many years, long after it had been superseded by other editions.

Some of our existing regulations are in the form of model ordinances which date back in some cases to an earlier day when the details were not so comprehensive. Such ordinances are satisfactory if frequently amended, but they involve a good deal of difficulty in securing amendment and offer opportunity for introduction of special features to satisfy the needs of local commercial interests and are in general undesirable.

One of the methods quite largely used is the adoption of reference material by title but without any date. This method, for example, is used in the 1956 Fire Prevention Code of the City of Philadelphia. It may be presumed, in case the matter is tested in the courts, that the latest edition of the standard in print at the time of adoption of the ordinance is the one contemplated. However, it is not the intent presumably to follow the original edition and difficulties might occur by this method.

As a matter of fact, at some other jurisdictions, this method of adoption has been declared unconstitutional by the courts, so presumably in such cases other factors have also entered. The Michigan State law adopted the National Electrical Code without reference to any date and this law was subsequently declared unconstitutional. However, in that case other factors were involved, in connection with electrical inspection, which were obnoxious to various interests.

The Prima-Facie Evidence Method

A method which has been widely advocated by electrical interests is making the National Electrical Code, or some other standard, prima-facie evidence of safe installation. This means evidence sufficient in law to raise a presumption of fact or establish the fact in question unless rebutted. It is difficult to accept the fact that the prima-facie evidence clause is valid without a date on the code adopted, because lacking a date this clause is subject to criticism as an unconstitutional delegation of legislative power, the same as any other method.

A much more serious criticism of the prima-facie evidence method of adoption is that it serves to protect the manufacturer or installer who complies with the code but who may introduce other hazards not covered by the code. An excellent example of this is found in the case of television installations which were not covered in the National Electrical Code when TV was first introduced. The television installer might thereby, under the prima-facie evidence law, plead that the installation was entirely in accordance with the National Electrical Code and hence legal even though it might have some serious differences based on a commonsense appraisal of the situation.

California Method

California and a number of other states have adopted laws making it permissible for municipalities to adopt the uniform building code of the International Conference of Building Officials. This law, which has been followed more or less in a number of states, reads as follows:

"An act relating to the passage of ordinances by cities or counties, and authorizing cities or counties to adopt ordinances relating to building construction, plumbing or electric wiring by reference to published codes on such subjects; provided not less than three printed copies of such code or codes, in book form, have been filed with the clerk.

"The People of the State of California do enact as follows:

"Section 1. Ordinances passed by cities or counties must be posted or published in a newspaper as required by their respective charters or the general laws; provided that ordinances establishing rules and regulations for such matters as the construction of buildings or the installation of plumbing or electric wiring, where such rules and regulations have been published as a code in book form, may adopt such code or portion thereof by reference thereto without further publication or posting, provided not less than three (3) copies of such code have been filed for use and examination by the public in the office of the clerk of such city or county, as the case may be."

This idea might be more effective if it were differently phrased in order to permit adoption by reference of all sorts of documents rather than the restricted list selected. The idea of having three copies on file at the city hall is good. This method, however, requires specific action of the legislative body each time a new edition of the reference material is forthcoming.

The State of Texas, some years ago, adopted NFPA Standards on Liquefied Petroleum Gas including future revisions. It is interesting to note that while this legislation was tested in the State Supreme Court and there upheld, this particular clause did not come into question in any way in the decision. The regulations were found to be reasonable under the circumstances and were accordingly upheld without reference to the adoption of new material by the NFPA in the future which seems to us clearly an unconstitutional delegation of authority (for a detailed discussion, see NFPA *Quarterly*, Volume 30, Page 217).

Georgia Method

Georgia has a rather interesting variant of the adoption by reference where in 1949 the Georgia Safety Fire Law was adopted. This provides that the commissioner shall adopt rules and regulations deemed by him necessary to promote the enforcement of this law, and the same shall have the force and effect of law. The final decision in the promulgation of rules and regulations rests solely with the commissioner, but there is an advisory board which assists him in developing them. The law goes on to state that the commissioner may promulgate reasonable rules and regulations embodying the fundamental principles of the Building Exits Code (1948 edition) dealing with exits, fire resistive partitions retarding the spread of flame and gas, fire prevention installations and all other such devises for the protection of life. Similar provisions are incorporated for large parts of the National Fire Codes, Volumes I and V, which are adopted by reference.

The interesting thing about this law is that the State of Georgia has continued to operate under it since 1949 with no changes. The Georgia State Fire Marshal, who operates under the commissioner, expresses the view that the fundamental principles of the Building Exits Code and the fundamental principles of other referenced documents have not changed since their original adoption in 1949 and that he may accordingly utilize more recent editions as he sees fit. In any case, the law seems to be working quite satisfactorily.

Throughout the body of the law, there are many awful and wonderful

forms of reference to documents of various kinds, references which would seem destined to be held unconstitutional or otherwise fail on the ground of indefiniteness if tested in the courts. That so few of such provisions have been so tested is due to the fact that presumably they are generally accepted standards utilized by the industries concerned and that with few exceptions, there is little incentive for bringing them into court. This is not true where other factors are involved such as peculiar local rules adopted by some enforcing authority for his own purposes, abnormal inspection procedures or other such factors.

In the long run anything that works should be satisfactory as a form of reference. The basic laws of the different states vary and the power and responsibilities of the individual cities thereon likewise vary. The best suggestion is that you utilize the existing law as far as it is working satisfactorily, but when adopting something new, follow if you can the suggestions in the first part of this article.

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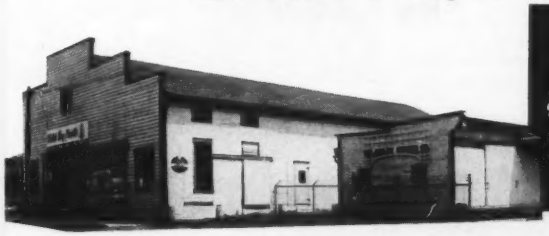

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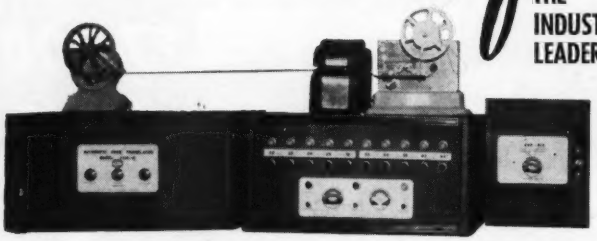

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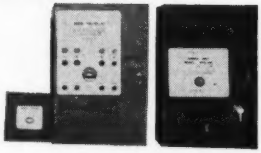

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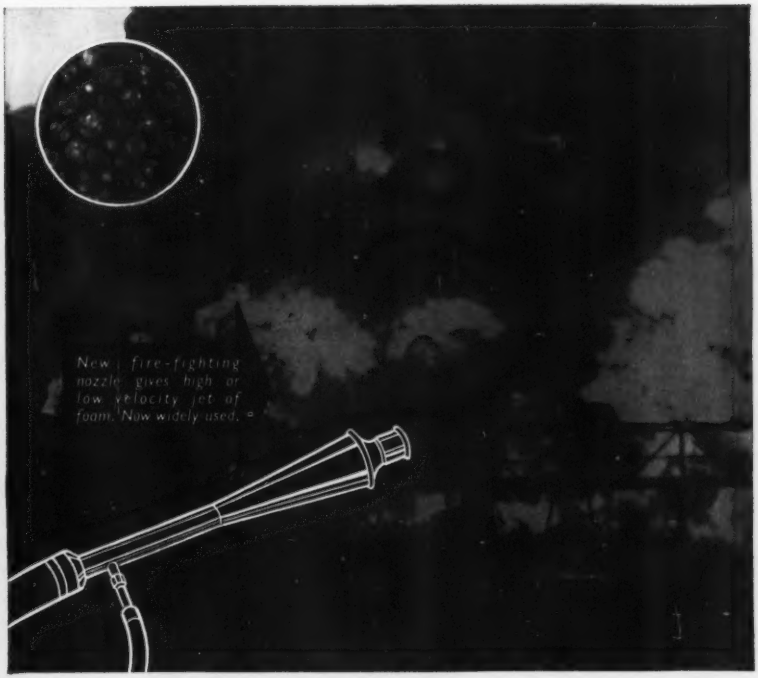

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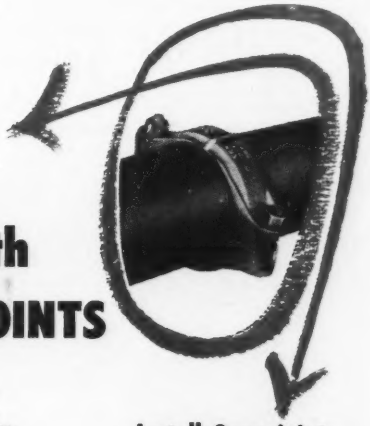


Now you can save up to 25% when connecting pipe for bulk runs and risers. Yes, contractors are saving money every day when they use new lightweight Gruvajoints. There's no flanging, no threading, no welding, and there's no need for heavy chain tongs or pipe wrenches. Gruvajoints are truly the modern way to couple pipe. Write today for free illustrated brochure on G-B Pipe Coupling Products. Gruvajoints are now available in 2", 2½", 3", 4", 5", 6" and 8" sizes.

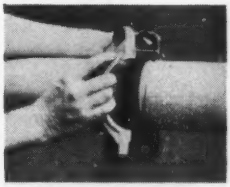
LISTED by
Underwriters' Laboratories, Inc.
File EX 1741A and B

APPROVED by
Factory Mutual Engineering Division
Report Serial No. 13097

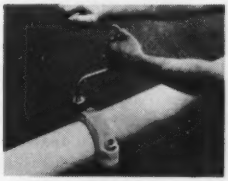
GUSTIN-BACON
manufacturing company
210 W. 10th St. Kansas City, Missouri

Install Gruvajoints in three easy steps

Grease gasket and center over pipe ends.



Lay housing halves into grooves and insert bolts.

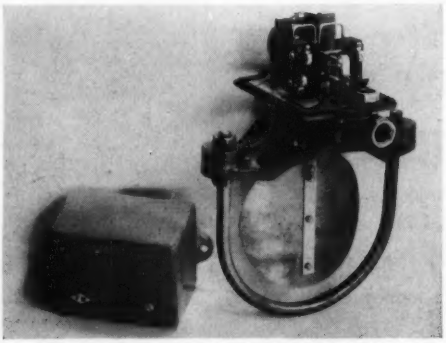


Tighten the two nuts equally.

CENTRAL STATION SIGNALS, INC.

Manufacturers of all kinds of approved devices used in Central Station Systems or Class 'A' or Class 'B' Proprietary Fire Alarm Systems, either automatic or manual.

53 WEST 23rd STREET . . . . . NEW YORK 10, N. Y.



Model PRS-1
Sprinkler
Waterflow Alarm

This device is approved by Factory Mutual Laboratories and Underwriters' Laboratories, Inc.

- This device is also made as Model PRT-1, a coded waterflow transmitter.

5-inch size shown above. To install simply drill 2-inch hole in pipe.

- Also made in explosion proof models.
- Made in all sizes from 2½" to 8".
- Has instantly recycling pneumatic retarding device, which prevents false alarms.
- Has enclosed electrical contacts for any voltage not exceeding 15 amp. 125 volts, A.C. and ½ amp. 125 volts, D.C. Operates on all water pressures or surges.

Size is 1⅝" x ⅝"

Tempo-Set Model A
Fire Detector

Underwriters' Laboratories, Inc. Approved.

- Self restoring and can be heat tested.
- Electrical contacts are silver or gold and are enclosed.
- Very reasonable price.

- Tempo-set Model A is approved in either open or closed circuit and the temperature ratings are 135 and 200 degrees.
- Approved spacing is 20' x 20'.
- Electric ratings are 125 volts 1 ampere, A.C. or 24 volts 0.5 ampere D.C. or less.

Let this "Visiting Fireman" train your men to fight fire... it could save your business

You have a *potential* fire-fighting team right in your plant. These would-be fire fighters *could save your business if fire struck unexpectedly*. All they need is training, the kind that will enable them to respond properly to any kind of fire emergency.

Ansul can provide this training for a group of your men just as it has for hundreds of its customers. And there will be no charge, of course. It is just one of the "essential" services that Ansul provides its customers.

Twenty years experience in the fire protection industry has proved to Ansul many times over that all the fire equipment in the world will not save your business *unless* trained hands are available to man that equipment. So, it is important to Ansul that you get *training* along with the fire equipment you buy. Only then will you experience the security that goes with having a complete fire protection program. Only then will you get what you really pay for, what you really need—*complete fire protection*.

You owe it to the life of your business to learn more about Ansul's in-plant fire training service. Get in touch with your local ANSUL MAN through the yellow pages of your phone directory. He will be happy to call on you and explain all of Ansul's customer services in detail. Or write to THE ANSUL CHEMICAL COMPANY, Dept. QN-1, Marinette, Wisconsin.

ANSUL

REEVE
HEAVY DUTY ALARM BELLS
GONGS and BUZZERS
Weatherproof
Watertight

Weatherproof —
Sizes 3", 4", 6", 8", 10", 12"
DC—6—220 V. · AC—12—220 V.

Watertight —
Sizes 3", 4", 6", 8", 10", 12"
DC—6—220 Volt · AC—12—220 Volt
60 Cycles, 110—220 Volt, 25 Cycles

3 TYPES OF
UNDERDOME BELLS
OPEN PIGTAIL • WEATHERPROOF • E-Z MOUNT
Sizes 6", 8", 10". Cast aluminum housing
Hot Pressed Steel Gong Shell
Single Stroke and Vibrating Types
Voltages are the same as Neck Type

Special Windings on request.

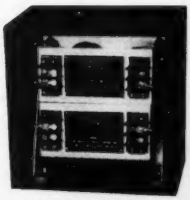
Seal of approval by UNDERWRITERS' LABORATORIES • FACTORY MUTUAL LABORATORY, INC. • UNITED STATES COAST GUARD

Write for Catalog Material and Prices!

AUTOMATIC BATTERY CHARGER, High and Low Current

The unit is designed for use on any storage batteries not subject to heavy drains. It will trickle charge the battery indefinitely because of its automatically decreasing rate of charge.

For use with six cells (12 volts). Automatically controlled by saturable reactor. Continuous output one ampere. 22.5 watts, 118 volts, 60 cycles. 3% Regulation. 9" x 9" x 6" — 14 B & S gauge steel wall cabinet. 15¼ lbs. U.L. Approved. No moving parts.



MODEL BC-12

Manufacturers of a complete line of
CENTRAL OFFICE and LOCAL FIRE ALARM DEVICES
• automatic alarm devices • sprinkler alarm and supervisory devices
• burglar alarm devices and accessories. DYNALARM (sound detection for both reverberant and non-reverberant vaults).

THE REEVE ELECTRICAL CO., Inc.
120 West 42nd Street, New York 36, N.Y.

GRIMES

AUTOMATIC
Spray
SPRINKLERS

UPRIGHT
MODEL SSU

PENDANT
MODEL SSP

FIRE SPRINKLER SYSTEMS AND EQUIPMENT

Engineered for better protection

ALARM VALVES
WATER MOTORS
VALVE DEVICES
DRY PIPE VALVES
RETARD CHAMBERS
CIRCUIT CLOSERS
EMERGENCY CABINETS
TRIMMINGS
SPRINKLERS — ALL TYPES AND FINISHES

NEW! MODEL A GRIMES ACCELERATOR

Manufactured and Installed by

GRIMES DEVICES
ARE APPROVED BY
ALL INSURANCE
INTERESTS

RAISLER
SPRINKLER DIVISION

RAISLER CORPORATION, 129 Amsterdam Ave., New York 23
Licensees in all principal cities in the United States and Canada

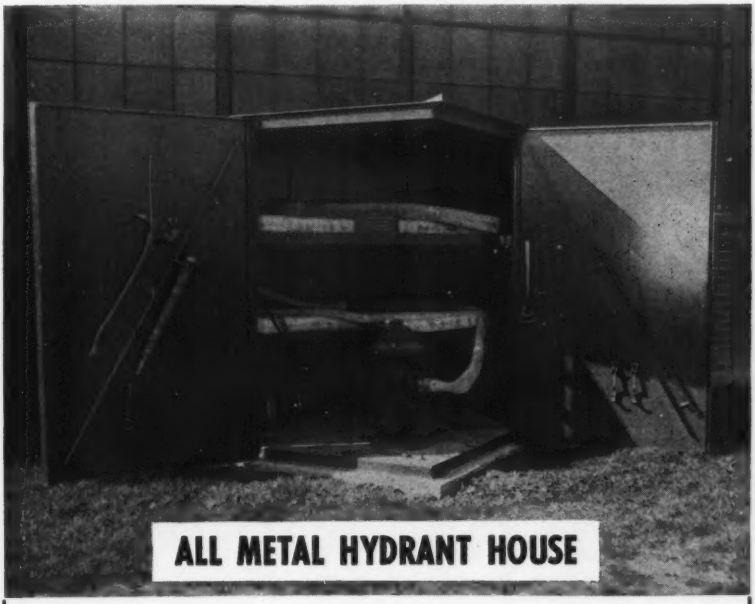
Tapping into a water main under pressure is a comparatively easy and simple operation with the use of an M & H Mechanical Joint Tapping Sleeve and Tapping Valve.

The sleeve has split-end gaskets and split glands, and may be used with Classes AB or CD pit cast pipe or Classes 100, 150, 200 or 250 centrifugally cast iron pipe. The glands have cup point set screws for centering them around the pipe. The sleeve has side and end gaskets of compound rubber which fit against each other to make a watertight seal.

The tapping valve is standard M & H design, double disc, parallel seat, NRS, and has a flange on one end for bolting to the tapping sleeve. The outlet end fits any standard tapping machine and may be ordered for either hub or mechanical joint pipe connection. Write or wire

M&H VALVE
AND FITTINGS COMPANY
ANNISTON, ALABAMA

SUBSIDIARY OF W WALWORTH



Many Architects and Engineers are specifying the Model 60 ALL-STEEL Hydrant House on new jobs and recommend their use for replacement of existing wooden houses as they wear out.

The advantage of a Hydrant House is that it protects the hose and hydrant during inclement weather when sleet or snow cause heavy icing. The hose is coupled and ready at any hour of the day or night. All steel houses are weathertight and rat proof — will not warp or dry out. (8) Eight Louvers are stamped in side panels for ventilation.

Doors are formed of 16 gauge metal. Roofs and side panels are 20 gauge. Shelves are perforated and formed of 14 gauge. Corner supports and hinge posts are formed of 12 gauge. Finished weight — 610 lbs.

Houses are shipped from stock, knocked down. Roof, base, shelves, doors and panels are completely prefabricated of galvanized iron with zinc plated hardware. Hinges are brass pinned. Two men with only a screwdriver and a wrench can erect it on foundations in less than one hour.

WRITE FOR QUOTATION ON YOUR REQUIREMENTS - NEW LOW PRICE

Manufactured by

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ENGINEERS AND FABRICATORS

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TWinbrook 3-4460 TWinbrook 3-4461

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Kinnear's exclusive AKBAR

STEEL ROLLING FIRE DOORS

...as tested and labeled by Underwriters' Laboratories, Inc.

3-HOUR Class A Label

of the Underwriters' Laboratories, Inc. is carried on AKBAR Doors *for ALL Installations* in*

interior

Fire Walls, Corridor and Room Partitions, and Vertical Shaft Openings

Automatic Closure in case of FIRE

"AKBAR" Doors, *made only by Kinnear*

1½-HOUR Class D Label

of the Underwriters' Laboratories, Inc. is carried on AKBAR Doors *For All Installations* in*

exterior

Wall Openings

"Akbar Fire Doors" for openings up to 120 square feet, but not exceeding 12 feet in width, or height, bear the label of the Underwriters' Laboratories, Inc. Doors for large openings will be furnished and upon request the Underwriters' Laboratories will furnish certificate of inspection, for doors covering openings not exceeding 24 feet in either width or height, indicating that their construction conforms to the requirements of the Laboratories.

The KINNEAR Manufacturing Co.

FACTORIES

2250-70 Fields Avenue, Columbus 16, Ohio 1742 Yosemite Ave., San Francisco 24, Calif.

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KINNEAR ROLLING DOORS

Saving Ways in Doorways

©

A piece of wire that might cause you disaster!

Defective or overloaded wiring is one major cause of industrial fires. Like all fires, they start small but grow rapidly—unless immediately stopped.

Call your local Pyrene-C-O-Two distributor today!

He carries a complete line of quality extinguishers, systems, brass goods, hose and accessories. Or write to:

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THE FYR-FYTER COMPANY

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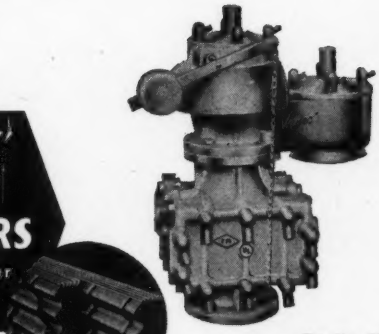
LOW COST
FIRE & EXPLOSION PROTECTION
for FLAMMABLE LIQUID STORAGE

WITH "Varec"
FLAME ARRESTERS
in combination with your
VENT VALVES



Flame Arrester Unit
listed by
UNDERWRITERS' LABORATORIES
Approved by Associated Factory Mutuals
Laboratories and other governing agencies.

Fig. No. 5800A
Conservation Vent Unit consisting of VAREC Vent VALVE in combination with VAREC FLAME ARRESTER

You can rely on VAREC CONSERVATION VENT UNITS to provide full fire protection on your liquid storage at low cost. Protection against entry of flame through the venting device is certain when Varec Flame Arresters are used. Protection against excessive pressure or vacuum is assured by the VAREC VENT VALVE. The combination unit gives you complete security against major hazards of flammable liquid storage. Average installation costs 1/10th of 1% of your investment in tank and products. Secure full details from your VAREC Representative or write factory.

NF-3

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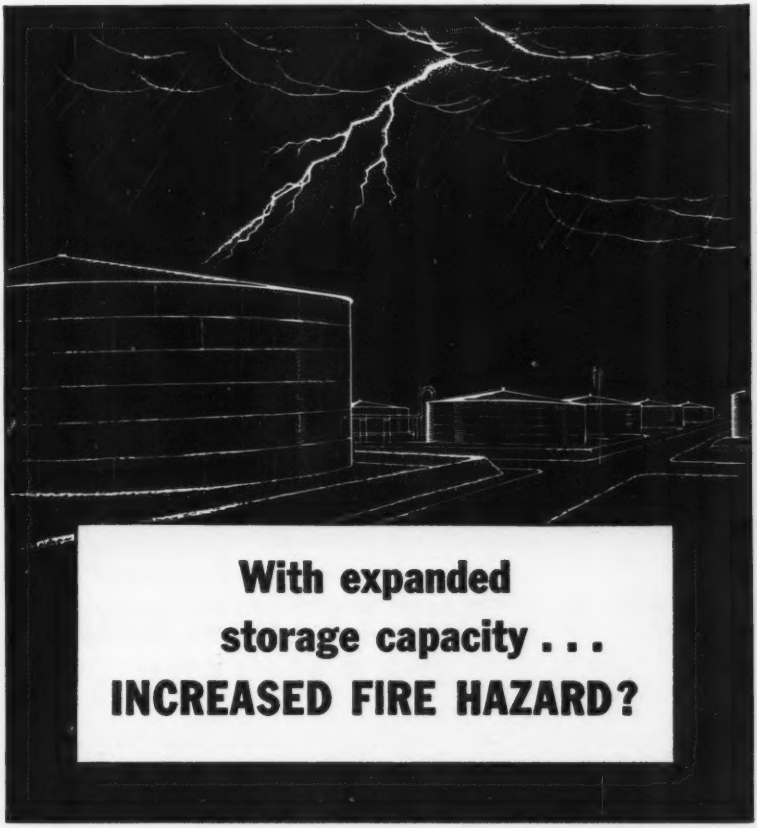
THE VAPOR RECOVERY SYSTEMS COMPANY

COMPTON, CALIFORNIA, U. S. A.

Cable Address: VAREC COMPTON USA
(All Codes)



Although greater storage capacity can spell big advantages in marketing, it is certain to bring an increase in fire hazard . . . particularly where flammable liquids are stored. Be sure your fire protection program grows with your capacity. Ask National Foam for expert recommendations.

NATIONAL FOAM System, Inc.
West Chester, Pa.

NATIONAL FOAM FIRE PROTECTION SYSTEM

The only company exclusively engaged in the design, development and manufacture of foam fire protection equipment and chemicals.

KEEP A KIDDE EXTINGUISHER NEAR EVERY HAZARD

Move fast against fire the instant it strikes, and you can stop it with little damage. But let it get a head start, and you may lose equipment, buildings . . . or your life.

Be selective in your choice of fire extinguishing equipment. Choose Kidde! You can be certain of rugged construction, simple operation, and absolute dependability.

For more than thirty years, Kidde fire extinguishers have been built to the most exacting specifications, have passed the most rigorous of tests, have the highest ratings. There is not a better-made extinguisher on the market today.

In ease of operation Kidde extinguishers also stand unsurpassed. The trigger-release grip on Kidde carbon dioxide and dry chemical extinguishers is the fastest and most natural to use. With it, even inexperienced operators can move swiftly and confidently against a blaze, extinguishing flames in seconds. You simply aim the horn, pull the trigger, and fire's out. Models with squeeze valves available too.

Finally, there is the Kidde service organization. In cities everywhere there are trained Kidde representatives who are ready to service your extinguishers.

For more information about the line of Kidde extinguishers, write for Kidde's P-8 Catalog.

Kidde

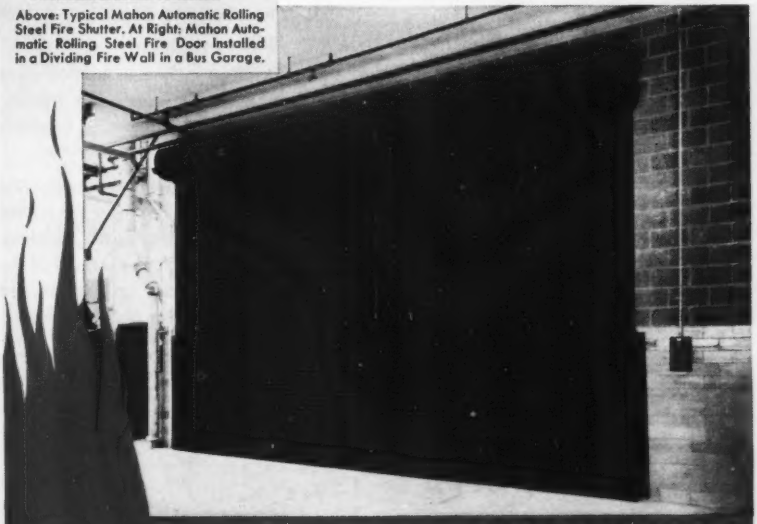
Walter Kidde & Company, Inc.
151 Main St., Belleville 9, N. J.
Walter Kidde & Company of Canada Ltd.,
Montreal—Toronto

Automatic Rolling Steel
FIRE DOORS *and* WINDOW SHUTTERS
PREVENT SPREAD *of* FIRE!

You need good automatic fire doors in fire walls, corridors, and vertical shafts . . . in some cases automatic rolling steel window shutters are necessary to protect your building and its contents from fires which may originate in nearby buildings. Many, many cases are on file which confirm that timely action of automatic rolling steel fire doors and window shutters have confined a fire to its point of origin and permitted its being extinguished with comparatively small damage. Make a survey of your building now, and don't delay action. You will find a Mahon Automatic Rolling Steel Fire Door or Window Shutter to meet each of your requirements—all bear the Underwriters' Label. These automatic fire doors may be operated manually or mechanically in every day use. If a fire should break out while they are in the open position, the automatic mechanism will close the door, cutting off drafts and preventing the spread of the fire. See Sweet's Files for complete information, or write for Catalog G-57.

THE R. C. MAHON COMPANY • Detroit 34, Michigan
Branch Offices in New York and Chicago • Representatives in Principal Cities
Manufacturers of Standard and Underwriters' Labeled Automatic Rolling Steel Fire Doors and Window Shutters; Underwriters' Rated Metaclad Fire Walls; Insulated Metal Curtain Walls; Electrified M-Floors; Steel Roof Deck; Acoustical Long Span M-Decks; and Acoustical and Troffer Forms.

Above: Typical Mahon Automatic Rolling Steel Fire Shutter. At Right: Mahon Automatic Rolling Steel Fire Door Installed in a Dividing Fire Wall in a Bus Garage.



MAHON ROLLING STEEL FIRE DOORS and WINDOW SHUTTERS

Is Your Building Safe From Fire?

TESTS PROVE —

Certain Roof Constructions A Major Fire Hazard

Extensive tests by Factory Mutual Laboratories have proven that the roof construction can be a major fire hazard in a building. What is the reason?

With conventional insulated metal roof deck constructions the area between the metal deck and the insulation is a fire hazard. This results from the use of flammable asphaltic materials for the vapor barrier and securement means.

When a metal roof deck having asphaltic materials between it and the insulation is exposed to a fire within a building, combustible gases are liberated from the asphaltic materials and forced down under pressure through the joints of the metal deck. These gases ignite, spreading the fire on the underside of the roof deck.

In order to prevent this chain reaction of fire, the flammable asphaltic materials must be eliminated from between the roof deck and insulation. Today this is possible with Lexsuco Fire-Retardant Roofing.

Lexsuco Roof Constructions featuring Koroseal Roof Vapor Barrier, Nonflammable Adhesive R907T, and the Lexsuco Insulation Clip make no contribution to the spread of fire within a building. Lexsuco Roof Constructions provide assured fire protection by eliminating flammable asphaltic materials from between the metal roof deck and insulation.

Factory Mutual Laboratories conducted a large scale fire test of the Lexsuco Roof Constructions which resulted in their giving Lexsuco Roofing a Class I rating with insulated metal roof deck constructions.

Lexsuco Roofing may cost a little more than flammable materials, but frankly, it costs more to make Lexsuco Products fire-retardant.

Always insist on assured fire protection and use Lexsuco Fire-Retardant Roof Constructions. "If it's worth building, it's worth protecting." For a copy of the new descriptive folder on assured fire protection, send in the coupon below.

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INCORPORATED

4815 Lexington Avenue, Cleveland 3, Ohio

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Name & Title . . . . . .

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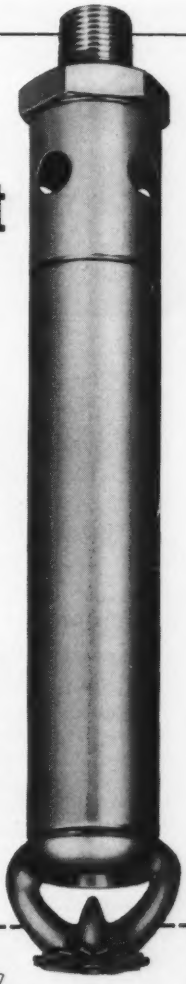
New Rockwood FOAMwater Sprinklers blanket burning liquids faster



Here's a device that combines the features of the well-known Rockwood FogFOAM application with that of the proven Rockwood WaterFOG Sprinkler!

This new FOAMwater Sprinkler used in Rockwood Fixed Piping systems offers greater protection for such hazards as airplane hangars, storage facilities or processes where flammable liquid and material are involved.

With the new Rockwood FOAMwater Sprinkler, systems can be designed to apply FogFOAM, and apply water if the FOAM becomes exhausted. It can be used with Rate-of-Rise Control or manual control, and is designed for open head operation only.

Tested and listed by Underwriters' Laboratories, Inc., the unit after 20 minutes of running water from the system proved that the FOAM blanket was still satisfactory.

Write for full data on this latest fire protection from Rockwood.

ROCKWOOD SPRINKLER COMPANY

Engineers Water... to Cut Fire Losses

ROCKWOOD SPRINKLER COMPANY
1655 Harlow Street, Worcester 5, Mass.

Please send me additional information on Rockwood's FOAMwater Sprinklers.

Name.....

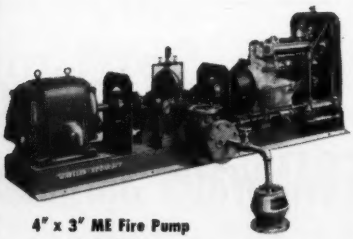
Title.....

Company.....

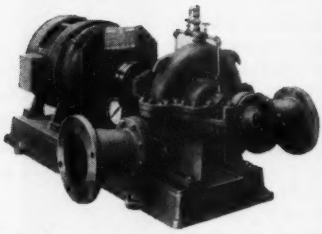
Street.....

City.....*Zone*....*State*.....

COMPLETE LINE OF PUMPS FOR FULL FIRE PROTECTION



4" x 3" ME Fire Pump with dual drive.



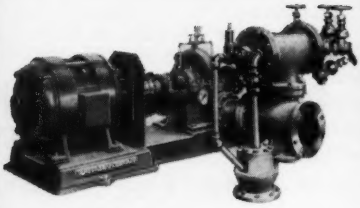
Wheeler-Economy Fire Pump fitted for Booster Service.

WHEELER-ECONOMY FIRE PUMPS

- Centrifugal Fire Pumps
- Centrifugal Booster Pumps
- Tank Filling Pumps

You can recommend Wheeler-Economy Fire Pumps for the needs of all commercial, industrial, public and private buildings.

Years of design, engineering and manufacturing have been devoted by Wheeler-Economy to develop a complete line of approved fire pumps.



Economy Fire Pump complete with Discharge Tee, Hose, Valves, Waste Cone, etc.

E UL FM

Write for Catalog L-154.

WE514R

WHEELER-ECONOMY PUMPS

C. H. WHEELER MANUFACTURING CO., ECONOMY PUMP DIVISION
19TH AND LEHIGH, PHILADELPHIA 32, PA.

Don't let it happen to you!

Fire is unpredictable. It strikes quickly, and when and where least expected. Unprotected property can be destroyed before the fire is put under control.

Don't let it happen to you. Be prepared. Be protected with a Blaw-Knox *Automatic* Fire Protection System. Blaw-Knox will engineer and install the right type of system for maximum protection, at minimum cost. And the system will pay for itself in a few years by savings in reduced insurance premiums.

"Little Joey Sprinkler always on the job"

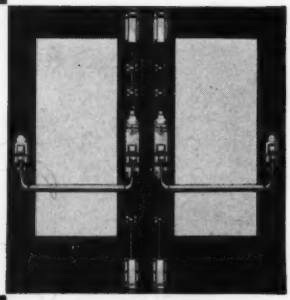
BLAW-KNOX COMPANY

Automatic Sprinkler Department
829 Beaver Avenue, N.S., Pittsburgh 33, Pa.

BLAW-KNOX

Get your exits

ready for increased traffic



Call in your

Von Duprin
"EXIT SPECIALIST"

● Increased production for your plant means more employes, more traffic, more need than ever for safe, dependable exits. Call in your Von Duprin "Exit Specialist" for a free survey of your exit requirements. From actual experience, he can recommend the right Von Duprin exit devices to give you the greatest safety and service. Von Duprin is the most complete line of approved exit devices. From this one line, you can meet *all* your present and potential exit hardware needs. If you don't know the name of your nearest "Exit Specialist," write Von Duprin.

FREE Reserve a showing of Von Duprin's 20-minute sound movie, "Safe Exit." Build a lively safety program around this interesting public service film. Write for a booking.

VONNEGUT HARDWARE CO. • VON DUPRIN DIVISION • INDIANAPOLIS

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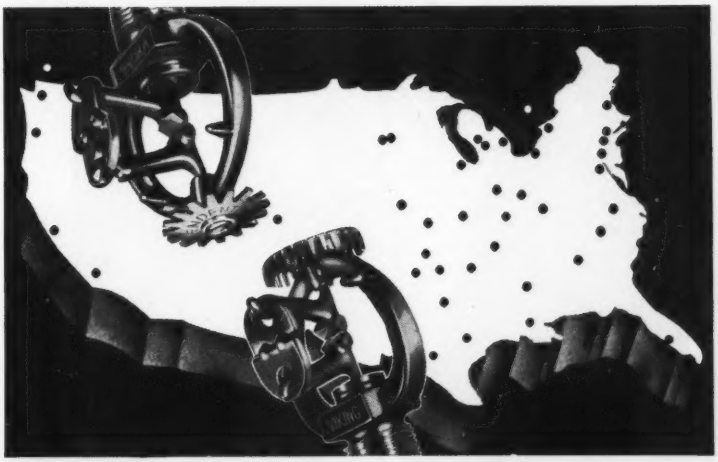
Von Duprin
Fire and Panic EXIT DEVICES

THE SAFE WAY OUT!



Viking SPRINKLER FIRE PROTECTION

for any condition whatever it happens to be!

ATLANTA — Crawford & Slaten Co. **BOSTON**—Viking Automatic Sprinkler Co. **BUFFALO**—Viking Automatic Sprinklers, Inc. **CHICAGO, MILWAUKEE** — Viking Automatic Sprinkler Co. **CINCINNATI, CLEVELAND, INDIANAPOLIS, LOUISVILLE** —Viking Sprinkler Co. **DALLAS, HOUSTON, JACKSON (Miss.), MEMPHIS, NEW ORLEANS, N. LITTLE ROCK, SAN ANTONIA, TULSA** — Texas Automatic Sprinkler Co. **DETROIT**—Viking Sprinkler Co. **GRAND RAPIDS** — Viking Sprinkler Co. of Western Mich. **HIGH POINT, N. C.** — Viking Sprinkler Co. **HUNTINGTON, W. VA.** — C. W. Hutchinson, Inc. **DECATUR (Ill.), DENVER, KANSAS CITY (Kan.), OMAHA, SAINT LOUIS, WICHITA (Kan.)** — Walton Viking Co. **LOS ANGELES, SAN FRANCISCO, PHOENIX** — California Viking Sprinkler Co. **HILLSIDE (N.J.), NEW YORK, MANCHESTER (Conn.)** — Viking Sprinkler Co. **PHILADELPHIA, WASHINGTON (D. C.), PITTSBURGH**— Viking Sprinkler Co. **PORTLAND (Ore.), SEATTLE, VANCOUVER (B. C.)** — Viking Automatic Sprinkler Co. **ST. PAUL, MINNEAPOLIS** — Hudson Viking Sprinkler Co. **TAMPA** — Florida Fire Sprinklers, Inc. **TORONTO (Ont.)**—Viking Automatic Sprinklers, (Canada) Ltd. **WINNIPEG (Man.)** — J. C. Davis, Ltd. **HASTINGS (Mich.)** — The Viking Corporation.

the Viking corporation

HASTINGS, MICHIGAN

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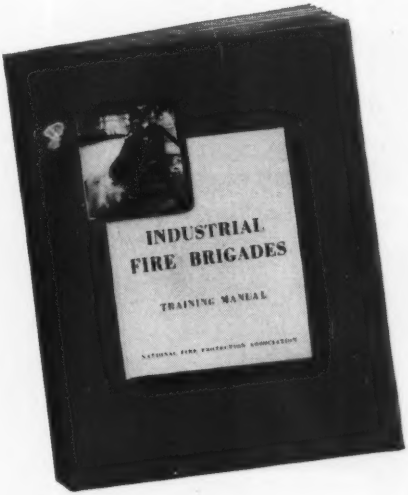

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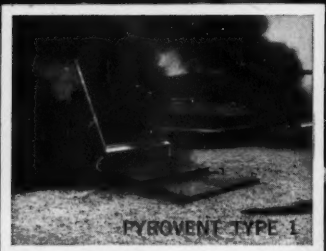

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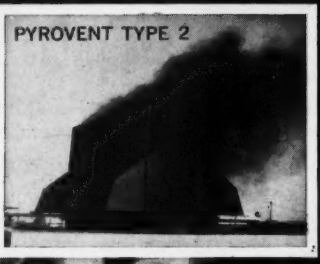

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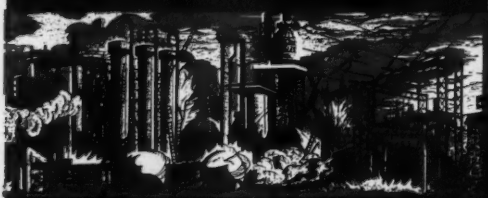

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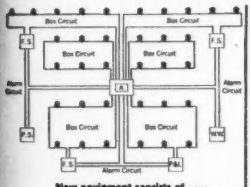
Lancaster, Pa., Reports...

New Automatic Alarm System Speeds Response to Alarms — Gives Extra Protection to Citizens



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Type B, Form 4 Central Office, replaces one installed in 1896.

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FIRE FACTS **Gamewell Type B Fire Alarm System** is completely automatic. Box circuits go to Central Alarm Station from where Alarm Circuits connect Fire Stations and all important Emergency Centers. Recording devices, and audio and visual alarm signals are furnished as required.

Remember-a Gamewell System is FIRST when seconds count!

A new Gamewell Type B, Form 4 Automatic Coded Telegraph Fire Alarm System is now on the job in Lancaster, Pa. It gives Chief Harry Miller a big edge in protecting life and property against the hazards of fire in his community.

Here's how...

At the instant a fire box is "pulled", coded signals are automatically transmitted to Fire Headquarters, and immediately retransmitted to all engine houses, the water department, police department, power and light plant and the fire chief's home — all simultaneously.

Result...

The entire fire defenses of Lancaster are mobilized within seconds . . . automatically. Men and equipment get to the scene during the vital first seconds of the emergency. The citizens are assured of the most effective fire fighting possible.

Ask for ALL the Facts

Gamewell experience with all types of fire alarm and signalling systems can help your community plan for maximum fire defense. A special FACTS KIT is available to answer questions on fire alarm systems and Gamewell will be happy to conduct a FREE Survey to assist you in planning. Write or call . . .

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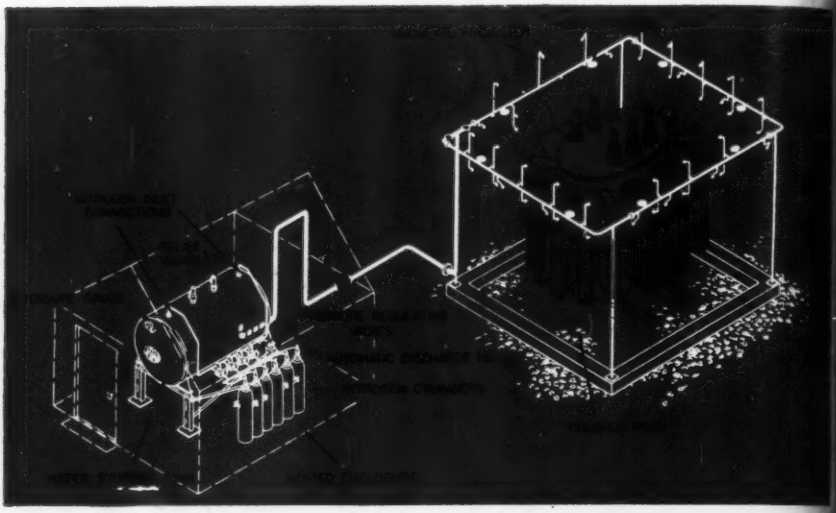
Grinnell Mulsifyre Protection with a Limited Water Supply



You need no longer be without water spray protection simply because your hazard is distant from city water mains. Grinnell's new limited water supply Mulsifyre System provides automatic detection and prompt water spray protection in extinguishing fires while still small, and in preventing their spread with possibly serious damage.

Water spray protection, of course, presupposes water under pressure. Grinnell's limited water supply system successfully achieves this through the use of nitrogen gas, stored in cylinders under high pressure, which drives the water from the storage tank at spray-forming velocities. As with all Grinnell Fire Protection Systems, the component parts of the limited water supply Mulsifyre System are fully listed by Underwriters' Laboratories and meet specifications covered in NBFU and NFPA Standards.

Your particular hazard will be thoroughly analyzed by the Grinnell Fire Protection Division, which introduced water spray protection in America — and has the widest possible background experience in its use. Full consideration will be given to the property to be protected, as well as to all other adjacent exposure hazards.

Let a Grinnell Fire Protection Engineer tell you more about this system. Grinnell Company, Inc., 274 West Exchange Street, Providence, Rhode Island. Branch offices in principal cities.

A Grinnell limited water supply Mulsifyre System operating to extinguish fire under test conditions.

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